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Case Report

Reduction of Porencephalic Cyst along with the Revival of Motor Control Using the Deep Brain Sound Stimulation (DBSS) Technology as a Novel Approach

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Abstract

A porencephalic cyst is a rare disorder, with the etiology of brain parenchymal loss as a result of perinatal cerebral ischemia or hemorrhage leading to the accumulation of cerebrospinal fluid within the parenchyma. It is diagnosed radiologically, and management depends on the clinical manifestations. The present case depicts a porencephalic cyst presenting with cerebral right-sided hemiparesis in adulthood. The cyst dimensions measured 2.6 cm × 0.6 cm × 0.5 cm in the left lateral ventricle with associated hemiparesis of the right side at the time of the first MRI scan before Deep Brain Sound Stimulation (DBSS) sessions. A reduction in the size of the cyst to 16 mm × 7 mm × 7 mm and then to a subsequent 8 mm was documented during a novel, non-invasive deep brain stimulation via sound treatment. In addition, right upper and lower limb power increased to 5/5 with improved coordination in a complete neurological evaluation. DEXA scan showed an increased bone density and muscle bulk.

Keywords: Porencephalic cyst • Deep brain sound Stimulation technology • Brainwave synchronization

Introduction

Porencephaly is a term introduced by Heschl in 1859 to describe a cavity that causes a broad range of physical, psychological, and neurological symptoms in the human brain [1,2]. The clinical presentation varies from minor neurological problems to severe disability or even death.

Deep Brain and Sound Stimulation (DBSS) refers to the use of external stimuli to produce a Frequency Following Response (FFR) of brainwaves to match the frequency of the external stimuli. The current case report focuses on the DBSS process as a novel non-invasive therapeutic approach to improve motor function control by gray matter stimulation. The therapy sessions were designed to affect the lateral ventricles, where the cyst resides, and the motor control systems to induce a measurable decrease in the cyst size (Figures 1 and 2 respectively). The reduction of a porencephalic cyst occurs with the disintegration of old gliotic tissue, and supplication of new white matter tracts though clear evidence is lacking. We stimulated and inhibited different white matter tracts using frequency algorithms, taking functional and Structural Connectivity (SC) networking, into consideration to achieve the desired physiological response.

DBSS brainwave protocol

A brain-stimulation protocol is used to express the desired brain wave frequencies across the timeline of an audio composition generated through a tone generator and modulator. It is divided into pairs of frequency group numbers, sub-group numbers, and rates of modulations. For example, stimulating different parts of the frontal cortex regions is done through the sub-group frequency numbers [3, 4]. Concepts of selected frequency number ranges and the used technology of ascending/descending sound signals and their modulations are based on the new technique for altering brain states on specific parts of the brain (brainwave entrainment) [5,6]. Therefore, it is a novel technique objective to provide different combinations of paired frequency ranges for stimulating specific brain areas.

Case Presentation

A 24-year-old young male, premature at birth, was diagnosed with infantile encephalopathy. He presented with hemiparesis on the right side with a power grade of 0/5. The first MRI scan reported a 2.6 cm × 0.6 cm × 0.5 cm porencephalic cyst in the left lateral ventricle. A marked difference in muscle mass, compared to the normal left side, was noted.

Investigations

Dexa Scan showed a T score and Z score of -1.7. The lean mass showed a 690 gm difference between the left and right upper limbs and a 1.687 kg difference between the left and right lower limbs. Decreased overall bone density, especially at the right limb is reported. Bilateral Bowing of tibial bones was noted and indicated a significant vitamin D3 deficiency, confirmed by blood tests. Decreased Growth Hormone (GH), PTH, IGF, and Testosterone levels below reference ranges.

Pre-session documentation of cranial MRIs

The first cranial MRI scan done in 2012 in 2D multiplanar section images showed the ventricular system was slightly asymmetric due to enlargement of the anterior horn of the left lateral ventricle due to traction induced by an ischemic lesion with dimensions of 2.6 cm × 0.8 cm × 0.9 cm shown in Figure 1. The contents of the two orbits displayed normal signal intensity and revealed a left frontal periventricular lesion with gliosis, and minimal, non-communicating hydrocephalus. A second cranial MRI scan revealed two lesions, one located at the corona radiata level with dimensions of approximately 22 mm × 9 mm × 7 mm (AP/CC/LL) and the other located apparently at the stria terminalis level with dimensions of 10 mm × 3 mm (LL/CC), at the supratentorial level of the left side, adjacent to the left lateral ventricle. The ventricular system was asymmetric around the midline due to left ventricular enlargement (most probably as a secondary effect of the adjacent cerebral lesions). Serum Growth Hormone levels before DBSS sessions were <0.05 ng/ml.

Post-session MRI scan

In June 2018, MRI revealed asymmetry in the ventricular system with two focal lesions. One was situated anteriorly approximately 16 mm × 7 mm × 7 mm in size, shown in Figure 2, and separated by the anterior horn of the left lateral ventricle. The other was located posteriorly, 6 mm × 4 mm × 6 mm, communicating apparently with the left lateral ventricle. Two lesions presented with a gliotic (sclerotic) halo. A potential arachnoid cyst could be located anterior to the left cerebellum, with dimensions of 33 mm × 21 mm × 10 mm (LL/CC/AP). Hypoplasia of the right vertebral artery was noted, with a compensatory enlargement of the left vertebral artery at the V4 (intracranial) segment. The last MRI scan report was conducted in June 2019 and revealed a cyst size of 8 mm × 0 mm × 0 mm with a recommendation to repeat the scan in 6 months-12 months.

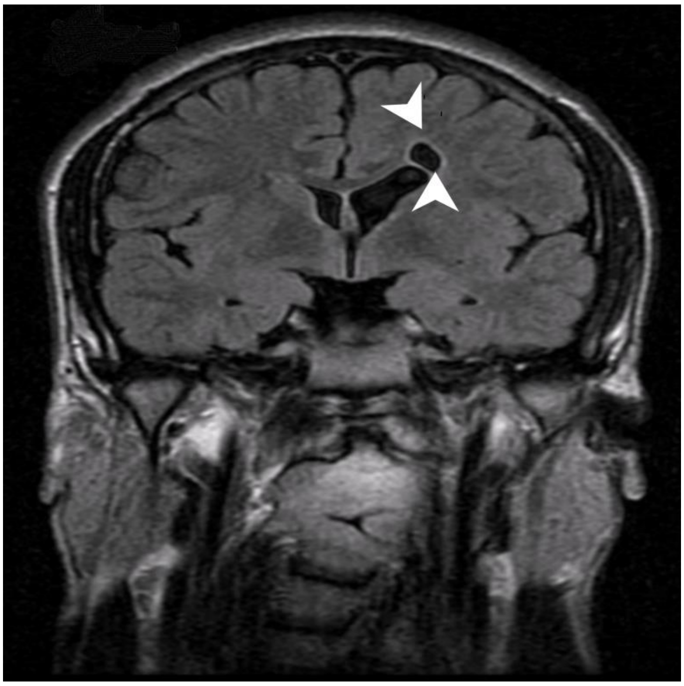

Figure 1. Showing cyst of 2.6 cm × 0.8 cm × 0.9 cm before exposure to DBSS sessions.

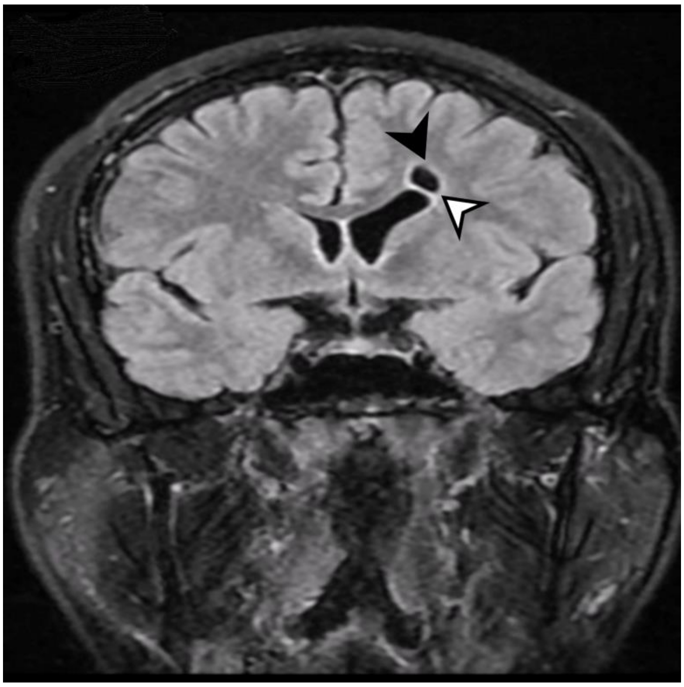

Figure 2. Showing cyst dimensions of 16 mm × 7 mm × 7 mm during the period of DBSS treatment sessions.

Results

The patient was exposed to DBSS monaural beat sessions (gamma- and lambda-band range) at specific frequencies. Monaural beat stimulation is achieved by applying the same amplitude-modulated tones to both ears, simultaneously. During and after each stimulation period, the patient was asked to make notes and evaluate his current state.

Session 1: was a test session to stimulate all the lateral ventricles, 2 minutes each had a shorter entrainment effectivity duration compared to DBSS standard used 3 minutes. After daily use of test sessions: 1 for five days' overall stiffness of muscles decreased. Limitations to holding objects with the right hand were decreased, and no side effects were noted. The subsequent full (3 minute) session was planned.

Session 2: Each lateral ventricle was stimulated for three minutes (a total of 39 minutes). This session was divided into two parts; Session 2a and 2b, for five weeks, the patient's right-sided motor control and physical skills showed marked improvement. The patient measured his right-sided muscle control progress using different tools and objects and through various daily training and activities. At four weeks, a session-free trial period was planned. Patient reported no setbacks. Compared with a scan in May 2017, cysts decreased in dimensions from 26 mm × 6 mm × 5 mm to 16 mm × 7 mm × 7 mm in an MRI scan performed in June 2018 after using Sessions 1 and 2 (during the first session-free week).

Session 3: The third session was administered to stimulate the thalamus (3a) and motor cortex (3b), used alternately for ten days each for 20 days with minor progress.

Session 4: Sessions 4a & 4b stimulated cerebellar upper and lower limbs, respectively. Sessions 4a/b used alternately for four weeks' increased fine tuned motor control skills to that of the normal contralateral side of the body compared to pre-session performance with no side effects.

Session 5: Similar to test session 1; a short 12 minute basal ganglia stimulation used for four weeks with no side effects, improved and extended motor control skills.

Session 6: Included a 33 minute stimulation of the basal ganglia for five weeks. The patient's motor control skills increased up to the normal side of the body.

Session 7: The patient had muscle mass imbalance throughout the right side of the body. We designed a new 30 minute session to stimulate the body's bone/muscle Growth Hormone and its regulatory systems. After seven weeks of daily use, vitamin D and GH levels showed marked elevation in all blood reports with no side effects.

Session 8: It was a 30 minute session designed to correct bowed legs. It stimulated specific leg/knee bone GH regulatory pathways. The patient used session 7 and session 8 alternately for 20 days. The bowed tibiae improvement was detected by a Dexa scan. A new MRI scan was done after five months of using all DBSS sessions. The cyst diameter decreased from 16 mm to 8 mm in the last scan (June 2018).

After approximately six weeks of using DBSS ventricle sessions, the cyst diameter decreased to 16 mm from 26 mm with enhanced motor skills, and the cyst further shrank to 8 mm after one year due to sessions 1 & 2 (lateral ventricle based), and 5 & 6 (basal ganglia) around the cyst's location probably with an increased blood flow. At the end of DBSS treatment, neurological examination revealed an intact motor function in the right Upper Limb (UL) and right Lower Limb (LL) with intact coordination and postural balance in comparison with the healthy normal side of the body.

Discussion

Porencephaly is a rare cephalic disorder involving encephalomalacia. The exact prevalence of porencephaly is unknown; however, studies revealed that 6.8% of patients with cerebral palsy or 68% of patients with epilepsy and congenital vascular hemiparesis have Porencephaly. So far, porencephaly has no definite treatment. However, several management options may include physical therapy, rehabilitation, medications for seizures or epilepsy, shunt, or surgical excision. Brainwave entrainment/brainwave synchronization and neural entrainment, refers to the hypothesized capacity of the brain to naturally synchronize its brainwave frequencies with the rhythm of periodic external stimuli, most commonly auditory, visual, or tactile, and can affect neural sensory gain, as confirmed by electrophysiological studies [7, 8]. The functional role of neural oscillations is not fully understood [9]. However, they seem to correlate with emotional responses, motor control, and several cognitive functions such as information transfer, perception, and memory [10-12]. This entrainment connects temporal and spatial scales of brain activity [13].

Billions of neurons in our brain communicate through synchronized and cyclical electrical signals detectable as EEG waveforms called brainwaves. Audio signals of differing frequencies, when applied to a listener's ear, utilized these audio signals to alter the brainwaves to match the audio signal. For instance, a low frequency signal may cause a listener's excited brainwave state to a lower frequency state. Yet, a method for altering brainwave states in specific brain areas is missing. Stimulating individual brain areas is an innovative technique that can enhance brain functions through the brainwaves and can provide solutions to treat various disorders in the following ways:

- Selecting an audio input comprising a range of frequency components;
- Selecting a brainwave protocol, comprising the desired brainwave frequencies across a timeline of the audio input [14-17].
- Providing a pair of combinations of brainwave frequency numbers means of stimulating specific areas of the brain) modulating and providing brainwave frequency modulation parameters correlating with the frequency numbers and then providing brain wave frequency in decimal number ranges aiming at focused stimulation of specific brain areas, thus devising a protocol for stimulating any parts or systems of the body after remixing the signals for final digital output.

A future direction would be to test this technology on other inoperable cases, such as brain cysts and tumors. The primary treatment option for most brain tumors is surgical resection/debulking. Alternative options, like Stereotactic Radiosurgery (SRS), radiotherapy, and chemotherapy are also available. A survey published in 2002 revealed that some surgeons refrain from performing high-risk surgeries, in an attempt to lower their professional liability insurance. Medicare data from 2009 to 2018, Lad et al.,2021 reported that the number of SRS procedures increased from 2009 to 2018 while the number of open surgical resections declined. Although theoretically, most brain masses are operable, surgery may not be practical in some cases, which could be tumor-related, such as size, grade, spread, and location, particularly if close to vital structures or patient-related.

DBSS-deep brain and sound stimulation is a safe, non-invasive alternative for inoperable brain tumors, tumor recurrence, or those with unsatisfactory radio or chemotherapy outcomes. DBSS is available at a reasonable cost with no reported side effects. Further studies on this technology would help tailor the required number and period of sessions for different types of brain cysts or masses.

Conclusions

We present deep brain sound stimulation technology, a novel technique to serve as an alternative management option for inoperable brain masses and cysts. DBSS consists of designing a case-specific brainwave protocol comprising the desired brain wave frequencies across a timeline of the audio input to stimulate the specific body or brain parts. The selected signals are adjusted with a remix to produce a final digital output. Audio sessions require administration by the patient under the supervision of a healthcare provider, who monitors symptoms for improvement and side effects.

We tested DBSS on a patient who presented with a porencephalic cyst and hemiparesis on the right side. A total of eight DBSS sessions were developed and used to induce a reduction in cyst size and to improve muscle mass, motor function, and bowed legs. MRI revealed a measurable shrinkage of the porencephalic cyst, with a remarkable improvement in the motor function of the right side of the body.

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