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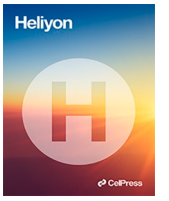

Case report

Jiao's style scalp acupuncture combined with physiotherapy for autosomal recessive spastic ataxia of Charlevoix-Saguenay type: A case report

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ABSTRACT

We present a case study of an 8-year-old girl with autosomal recessive spastic ataxia of Charlevoix-Saguenay, who experienced gait imbalance since the age of two. Magnetic resonance imaging of the brain and whole spine, as well as electroencephalography, revealed no abnormalities. However, genetic testing identified a likely pathogenic variant and an uncertain significance in the heterozygous state of the Sacsin Molecular Chaperone gene. Despite treatment with epileptic and antiparkinsonian medications, along with supplements, no significant improvements were observed. Subsequently, the patient underwent eight sessions of physiotherapy before starting with 14 sessions of combined *Jiao's* style scalp acupuncture targeting the motor and chorea-tremor areas with physiotherapy treatment. Positive changes were noted in the Trunk Control Measurement Scale (TCMS) and Pediatric Balance Scale (PBS) after three sessions of combined treatments from 25 to 36 and 21 to 43 respectively. Further combined treatments showed consistent improvements where the TCMS reached a peak of 57 out of 58 and PBS showed a peak of 54 out of 58 at the 6th month of combined treatment. This suggests that the combination of scalp acupuncture with physiotherapy treatment may provide improvement in the balance and gait of patients with ARSACS. More similar cases should be documented to better understand the potential benefits and synergies of both treatments of ARSACS.

1. Introduction

Ataxia is characterized by uncoordinated movement and loss of balance during voluntary activity due to poor muscle control [1]. Ataxia can be categorized into several types, including primary ataxias, secondary ataxias and idiopathic degenerative ataxias [2]. Spastic ataxia of Charlevoix-Saguenay type is one of the types of primary ataxia, also known as the autosomal recessive spastic ataxia of Charlevoix-Saguenay (ARSACS) [2]. ARSACS is caused by mutations in the Sacsin Molecular Chaperone (SACS) gene and typically presents during early childhood or adolescence [3].

The incidence of ARSACS worldwide is currently unknown. However, the incidence is estimated to be 1 in about 2000 individuals

Abbreviations: CT, computed tomography; EEG, electroencephalography; MRI, magnetic resonance imaging; PBS, Pediatric Balance Scale; SACS, Sacsin Molecular Chaperone; TCMS, Trunk Control Measurement Scale.

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[4]. Originally, ARSACS had an elevated frequency in two northeastern Quebec regions, namely Saguenay-Lac-St-Jean and Charlevoix before being identified in patients worldwide [4]. ARSACS is characterized by a combination of progressive cerebellar ataxia and spasticity [5]. Cerebellar ataxia refers to a lack of coordination and balance resulting from dysfunction or damage to the cerebellum. Individuals with ARSACS often experience difficulties with gait, balance, and coordination, as well as unsteady and uncoordinated movements. Spasticity, on the other hand, refers to an increase in muscle tone and stiffness. ARSACS patients commonly exhibit spasticity in the lower limbs as compared to the upper limbs [6]. Other symptoms include muscle weakness, progressive vision loss, sensory abnormalities, and tremors [5]. The prognosis of ARSACS is usually poor with disease progression as the patient ages [7].

The diagnosis of ARSACS involves careful history taking, evaluation of family history, physical examination, and genetic testing to identify mutations in the SACS gene [1,8]. The treatment of ataxia aims to address spasticity, tremor, dystonia, pain, cognition, or depression, including physiotherapy [9–11], deep brain stimulation [12], transcranial magnetic stimulation [13,14] and acupuncture [15,16]. Physiotherapy is a commonly used treatment to manage spasticity and balance in ataxic patients, by employing static and dynamic balance exercises, as well as coordination exercises [11]. On the other hand, treatments such as deep brain stimulation, transcranial magnetic stimulation and acupuncture have demonstrated success in individual reported cases. However, deep brain stimulation carries the risk of surgical complications, postural instability and gait ataxia [17], while transcranial magnetic stimulation's efficacies may be influenced by various factors including target position, intensity, frequency, number, and duration of sessions, as well as patients with personal or family history of epilepsy are contraindicated from this treatment [18]. Acupuncture, particularly scalp acupuncture, is based on the reflex somatotopic system found on the surface of the scalp and has minimal side effects such as discomfort and bleeding at the needle insertion site [19]. The combined use of acupuncture following a rehabilitation program on patients with ataxia was reported on a patient diagnosed with sensory ataxia following cerebral hemorrhage. The patient received acupuncture on acupoints at the head, palm, and feet after receiving rehabilitation program for three years to improve the proprioception and dynamic balance [15].

In this report, we present the case of a child diagnosed with a possible ARSACS who underwent acupuncture and physiotherapy sessions to address her coordination and balance issues.

1.1. Case Report

An 8-year-old girl presented to the International Medical University Chinese Medicine Centre (ICMC) in April 2022 with complaints of gait imbalance since the age of two, with history of recurrent falling and requiring assistance while climbing stairs.

1.2. Genetic testing and radiological examination

In December 2016, the patient sought consultation with a doctor in the United States of America due to progressive cerebellar ataxia, gait instability, abnormal ocular motility, and clonus. Genetic testing was performed on the patient's blood, as well as samples from both parents. The result revealed a likely pathogenic variant in the SACS gene despite neither parent carrying the variant. No further treatment was advised at that time.

In August 2017, the patient sought treatment in Jordan for gait imbalance and difficulty with fine motor skills, such as writing. Electroencephalogram (EEG) testing, brain magnetic resonance imaging (MRI) and whole spine MRI were performed. The EEG results showed normal presentation without any focal, diffuse, or generalized abnormalities. The brain MRI revealed normal presentation without any focal brain pathology, hydrocephalous, brain atrophy or congenital brain anomalies. The whole spine MRI showed normal vertebrae alignment, normal vertebrae body height, normal intervertebral disk spaces, and no pathology in the spinal cord, spinal canal or lumbosacral spine. There was no evidence of tethering of the spinal cord, myelomeningocele, or any other congenital anomaly (Appendix 1). The patient was prescribed with epileptic medication such as Topamax and Gabatrex, antiparkinsonian medication such as PK-Merz, cardioprotective medication such as Indicardin, and supplements such as Vitamin E and Zinc tablets. However, none of the medications improved the symptoms, and were discontinued in May 2019 by the patient and family members.

1.3. Detailed physical examination and supplements intervention

In July 2019, the patient was admitted to a hospital in Saudi Arabia under the Pediatric Neurology department with similar and progressive complaints of gait imbalance, recurrent falling and requiring assistance while walking the stairs. The patient still had fine motor skills dysfunction and had difficulty supporting herself while sitting, accompanied by fecal incontinence. In terms of family history, both parents were healthy with unremarkable medical history. The patient has a younger brother who is generally healthy, but her maternal uncle had a history of epilepsy for 28 years and is on Depakin 200mg BID.

On examination, the patient's vital signs were stable and within normal limits. The patient had a full Glasgow coma scale score and was awake, alert, active, and oriented to time, place, and person. No nystagmus was observed. The patient was able to speak in full sentences and count from 1 to 100. Neurological examinations revealed an imbalanced gait with a positive finger-to-nose and supination-to-pronation test. Further examination showed intact cranial nerves, normal muscle power and tone in both upper and lower limbs, normal reflexes in the upper limbs, but hyperreflexia in the lower limbs. There was no muscle wasting or hypertrophy observed. The diagnosis of chronic slowly progressive ataxia due to a genetic defect was provided and rehabilitation was recommended. Dietary supplements such as oral L-Carnitine 300mg TID and oral Thiamine 100mg TID were prescribed for a duration of 30 months.

1.4. Physiotherapy and acupuncture intervention

In January 2022, the patient visited a pediatrician and child neurologist in Malaysia and started a physiotherapy and rehabilitation program in March 2022. The physiotherapy assessment in March 2022 revealed normal muscle power in both the upper and lower limbs, with slight reduction to 4 out of 5 in the bilateral hip extensors and abductors. Range of motion was within normal limits, and there was no loss of sensations in the upper and lower limbs. The patient had normal reflexes in the upper limbs but hyperreflexia in the lower limbs. The finger-to-nose test was positive, but the patient was able to write in coordinated letters and had normal speech. Additional findings included a positive heel-to-shin test, positive Romberg's test, and an ataxic gait characterized by mild loss of arm swing. Both the pediatrician and physiotherapist advised performing physiotherapy treatment. Simultaneously, the pediatrician strongly recommended another genetic testing with CentoGene in Germany for further analysis and samples were sent for testing in January 2022.

The physiotherapy and rehabilitation program started in March 2022. The initial exercises included Frenkel exercises, mobility and balance training, and fine motor function exercises. Later, Romberg exercises, gait training and coordination exercises for the upper and lower limbs were progressively introduced. Each physiotherapy session would consist of the relevant exercises for a period of about 1 h.

In April 2022, the patient's parents decided to explore acupuncture as a potential intervention. A Chinese Medicine practitioner at ICMC conducted a thorough history taking, physical examination, and review of the patient's previous medical reports and interventions. To access trunk control and balance, the Trunk Control Measurement Scale (TCMS) and Pediatric Balance Scale (PBS) were administered. The initial TCMS score was 21 out of 58, and the PBS score was 25 out of 56.

Based on the assessment, *Jiao's* style scalp acupuncture was chosen as the treatment approach [20]. Specifically, two areas on the scalp were selected: the motor area and the chorea-tremor area (Fig. 1). The precise location and indications for these areas can be found in Appendix 2.

For the acupuncture procedure, sterile disposable stainless acupuncture needles (Seirin Corporation, Shizuoka, Japan) measuring 13mm in length and 0.25mm in diameter were bilaterally inserted into the patient's scalp. A total of 12 needles, with three inserted on

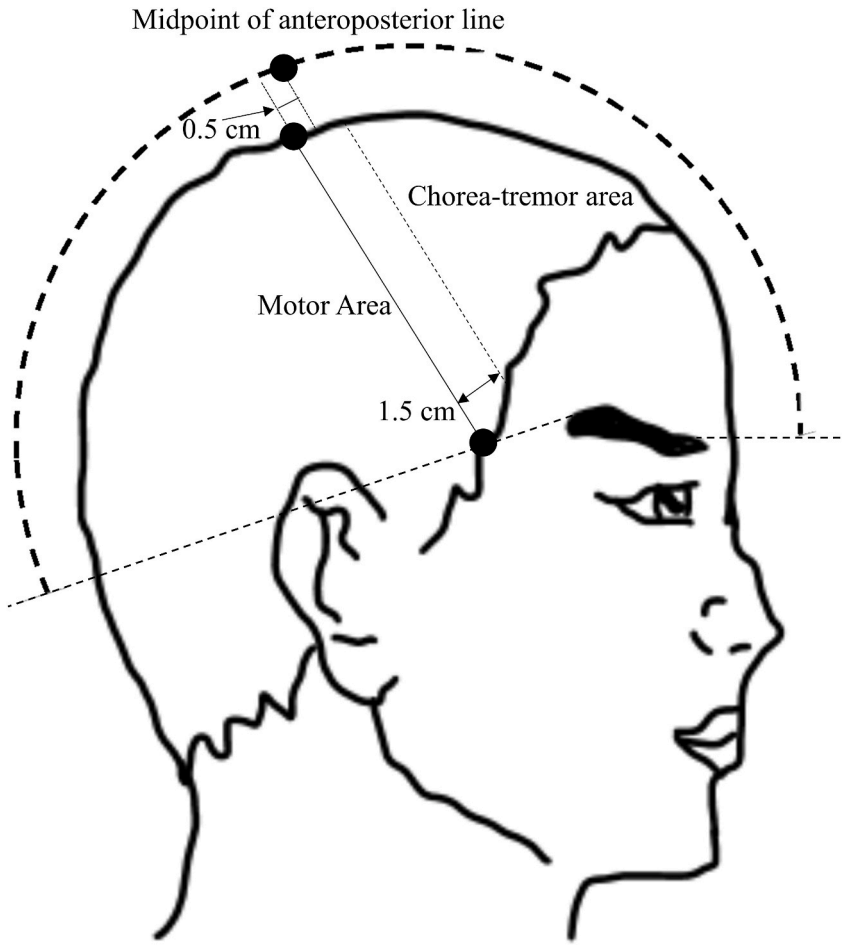

Fig. 1. Motor area and chorea-tremor area of the scalp acupuncture used in this case.

each line of each side, were placed at a depth of at least 10mm. The procedure was performed by qualified Chinese Medicine practitioners with at least 5 years of experience, registered with the Traditional and Complementary Council of the Ministry of Health, Malaysia. The needles were manipulated with twirling, lifting, and thrusting to achieve a sensation of *de qi*, characterized by soreness, heaviness, and distension. The needles were then retained for a duration of 20 minutes before being carefully removed. During one of the scalp acupuncture sessions, bleeding on the scalp around the needling site was observed after needle removal, and immediate pressure was applied using cotton to stop the bleeding.

The patient received scalp acupuncture once every week before continuing with physiotherapy treatment starting from April to October 2022, completing a total of 14 combined sessions. The chronological timeline of examinations and interventions is summarized in Fig. 2.

1.5. Outcomes and assessment

Throughout the 14 sessions of scalp acupuncture with physiotherapy treatments, the patient's progress was evaluated using TCMS

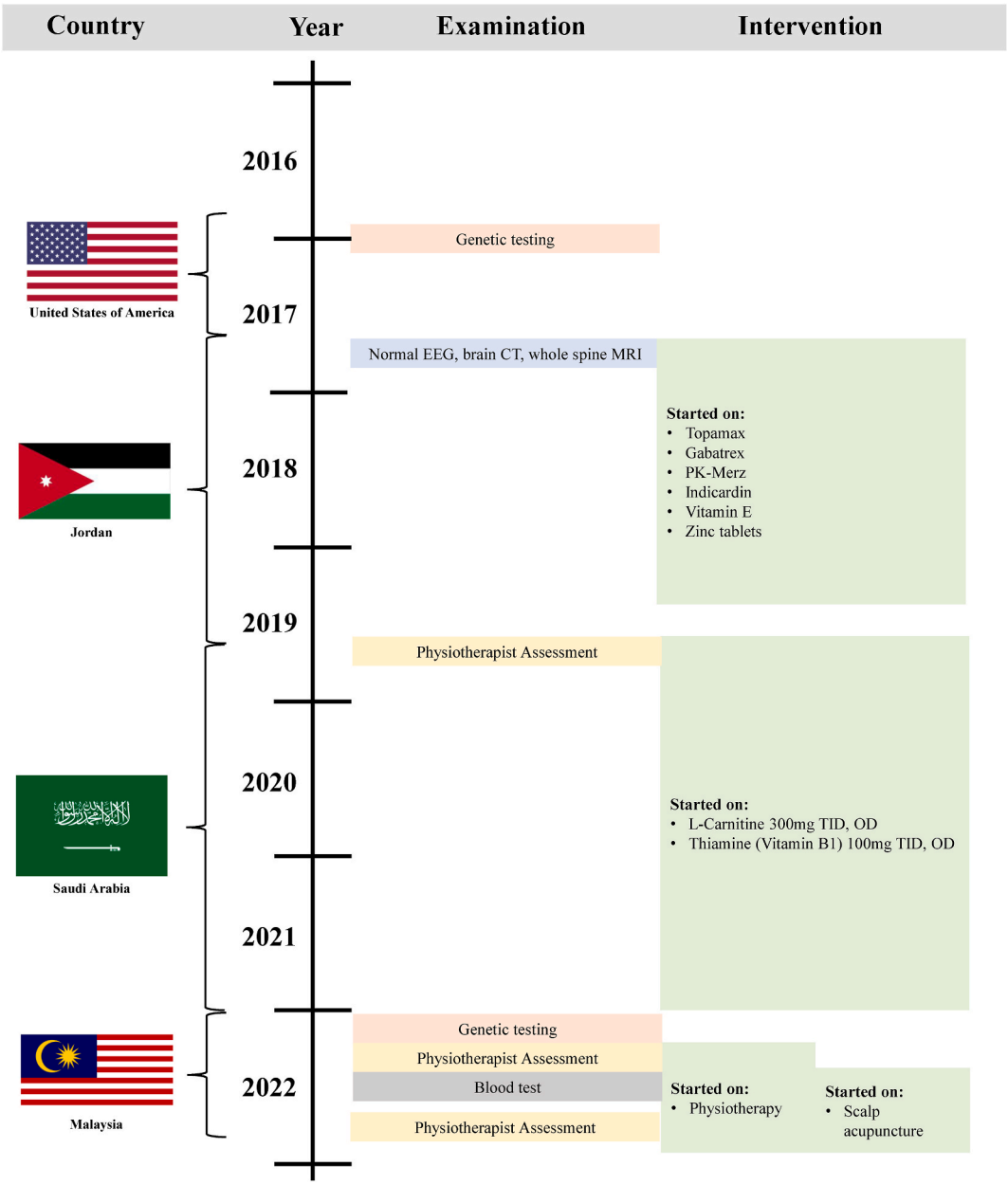

Fig. 2. Timeline of examinations and interventions.

and PBS. During the initial visit in April 2022, the TCMS score was 21 out of 58, and the PBS score was 25 out of 56. The patient also had gait imbalance with occasional falling to the sides and crossing of legs when walking (Fig. 3A). Significant improvements were observed in the 3rd session, which took place four weeks after the first treatment, with TCMS improving to 43 out of 58 and PBS to 36 out of 56. Further progress was noted on the 5th visit, which occurred six weeks after the first treatment, with TCMS reaching 51 out of 58 and PBS reaching 46 out of 56. Additionally, it is noteworthy that the patient revealed a significant improvement in fecal incontinence following the initiation of scalp acupuncture treatment.

After the 5th visit in May 2022, the results of the second genetic testing were received, which identified two variants of uncertain significance in a heterozygous state in the SACS gene. This is similar to the findings of the first genetic testing conducted in December 2016. The genetic diagnosis of ARSASC type is possible, and further analysis of genes from the parents was recommended to confirm the phase of the variants. Genetic counselling and retrospective clinical analysis to evaluate compatibility of the phenotype with the identified variants were recommended.

The patient continued with both scalp acupuncture and physiotherapy treatment, and both scores remained stable and showed continued improvement from the 6th to 9th sessions from end of May till early July 2022. The TCMS score ranged between 52 and 55 over 58 and PBS ranged between 47 and 49 out of 56. The TCMS score increased in the aspect where the patient improved in terms of balance reacting to sideways perturbations. The PBS score increased in two aspects in terms of balance when performing sitting to standing motion without using hands compared to using of hands in earlier treatment sessions, as well as improved balance when standing with feet together. On the follow up session after three months of combined treatments, patient's gait improved slightly with occasional falling to the sides and no longer crossing of legs when walking (Fig. 3B).

In September 2022, the patient revisited the physiotherapist for a reassessment. The assessment included evaluating full muscle

Fig. 3. Patient's gait improvement after receiving scalp acupuncture combined with physiotherapy treatment. (A) Initial assessment; (B) 3-months follow-up; (C) 6-months follow-up.

power in the upper and lower limbs, with slight improvement in muscle power on bilateral hip extensors and abductors (4+ out of 5). In terms of static balance, the patient's standing and sitting were fair, while in dynamic balance, the patient's standing and sitting were moderate. Coordination wise, the finger-to-nose test was unsteady and needed moderate contact guarding (grade 2), and the heel-to-shin test showed minimal impairment, with less than normal speed and required supervision (grade 3).

During the 10th visit in September 2022, a slight decline of the TCMS score from 55 to 46 out of 58 and PBS score from 48 to 45 out of 56 was observed, coinciding with a period of school holidays between mid-July to mid-September 2022 when the patient was unable to receive both physiotherapy and scalp acupuncture treatment. Nevertheless, after resuming the treatments, both scales showed renewed improvement, where TCMS score increased from 46 to a range of 50–57 out of 58, and PBS increased from 45 to a range of 48–54 out of 56 at the 6th month of treatment. In the TCMS score, the patient improved in terms of balance reacting to forward and backward perturbations, as well as rotation in sitting. As for the PBS score, the patient improved in terms of balance when standing with one foot in front, standing on one foot and turning in 360°. On the follow up session after six months of combined treatments, the patient's gait improved with neither falling to the sides nor no longer crossing of legs when walking (Fig. 3C). The progress of TCMS and PBS scores throughout the scalp acupuncture combined with physiotherapy sessions are illustrated in Fig. 4.

2. Discussion

We have reported a case of an 8-year-old girl diagnosed with possible ARSACS treated with scalp acupuncture alongside physiotherapy treatment for at least 6 months. Given that such type of ataxia is rare, this is the first case report investigating such a treatment combination to recover the physical functions of balance and gait. In this case report, the patient's balance and gait are being evaluated using TCMS and PBS, scales commonly used in clinical settings for evaluating trunk control and balance in children [21,22], where both show improvement. Notably, the patient reveals no instances of fecal incontinence following the initiation of scalp acupuncture treatment, suggesting a potential positive effect on the motor movement. However, a scale was not used to quantify fecal incontinence due to patient's perception of mild symptoms.

Scalp acupuncture, either as a sole treatment or in combination with rehabilitation training, has been used to treat various disorders, including balance and gait dysfunction, as well as cognitive dysfunction seen in stroke [23–26], Parkinson's disease [27], and cerebral palsy [19]. There are different styles of scalp acupuncture, such as *Zhu*'s style [28], *Jiao*'s style [20], *Lin*'s style [29], and an International Standard Scalp Acupuncture style [30]. However, in this case, the *Jiao*'s style scalp acupuncture was employed as practiced by the practitioners. The motor area and chorea-tremor area of the *Jiao*'s style scalp acupuncture were chosen because they correspond to the motor cortex and precentral gyrus areas, which are responsible for the control of voluntary movement [19,31]. By stimulating both areas, it can have an activating effect on the cerebrocerebellum and observe changes in the motor cortex and thalamus under functional MRI [31].

The pathogenesis of ARSACS involves abnormalities in the SACS gene, which is responsible for encoding the sacsin protein in the central nervous system [7]. Production of an abnormal sacsin protein can lead to disruption of the normal cellular processes, such as abnormal mitochondrial function [32], protein homeostasis [33] and cytoskeletal organization [34]. Gene replacement therapy is a potential solution to introduce a functional copy of the defective SACS gene, but this method is currently unavailable [35]. Moreover, there are no other known genes that can directly replace the function of SACS gene in ARSACS [36]. Hence, the improvement seen in the patient following scalp acupuncture and physiotherapy treatment could be due to the potential modulation of the downstream effects and pathways in the disrupted cellular processes. Research have shown that acupuncture may enhance mitochondrial respiratory chain enzyme activity, improve mitochondria dysfunction, and reduce the number of apoptotic cells via the PI3KIII,

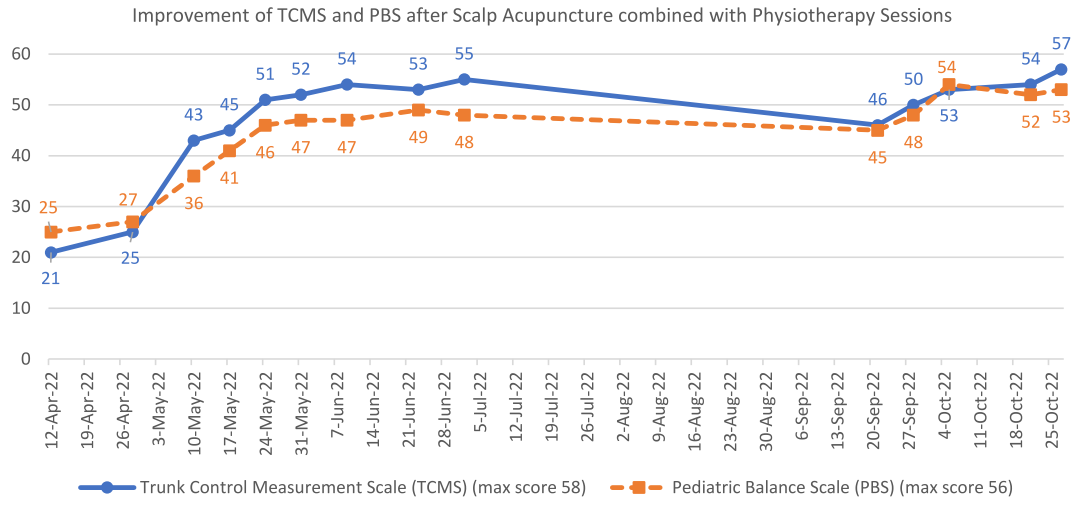

Fig. 4. Improvement of Trunk Control Measurement Scale (TCMS) and Pediatric Balance Scale (PBS) after 14 sessions of scalp acupuncture combined with physiotherapy was performed.

PINK1/Parkin and NIX pathways [37,38]. On the other hand, physiotherapy has been shown and strongly recommended in all patients with mitochondrial disorders such as patients with spasticity due to central nervous system involvement [39], as well as resistance training could increase muscle strength, increased the proportion of neural cell adhesion molecule-positive satellite cells and improved muscle oxidative capacity [40].

Currently, the efficacy of acupuncture in improving overall balance has been observed in ataxia patients as reported in the following cases [15,16]. It is worth noting that acupuncture can enhance proprioception, dynamic balance, and strength in lower extremities in one patient diagnosed sensory ataxia following cerebral hemorrhage and received rehabilitation treatment for three years [15] and another patient diagnosed with spinocerebellar ataxia for 3 years without receiving any symptomatic treatment [16]. Observations from both cases showed similarity to the current case presented, where patient's balance improved after acupuncture treatment was administered alongside physiotherapy treatment.

Although ARSACS is rare, more similar cases should be documented, and it is currently unclear whether there would be a synergistic effect of both treatments towards the treatment of ARSACS. Hence, well-designed prospective studies should be conducted to verify the efficacies of scalp acupuncture in combination with physiotherapy for patients with ARSACS. Furthermore, studies with only one patient would limit the generalizability of the findings and the ability to establish a cause-and-effect relationship. Additionally, while the quality-of-life for individuals with ataxia can be a concern due to the symptoms, the quality-of-life assessment was not included in this report as the focus was primarily towards the chief complaint of the patient. Besides, incorporating objective assessment by using tools to measure the alleviation and improvement of patient's symptoms could provide valuable and quantifiable data. Therefore, it is recommended that future studies consider including a quality-of-life scale and relevant objective assessments such as electromyography or gait analysis to possibly enhance the comprehensiveness of investigations. Consequently, the results obtained should be interpreted as preliminary evidence, and future studies should consider incorporating control groups and performing long term follow-up to evaluate the sustainability of treatment effects, as well as assessing whether the improvements would persist over time.

3. Conclusion

In conclusion, the combination of scalp acupuncture alongside physiotherapy treatment may provide improvement in the balance and gait of patients with ARSACS. However, the presence of a synergistic effect of both treatments remains unclear. Hence, more similar cases should be documented, given that ARSACS is rare. This would contribute to a more comprehensive understanding of the potential benefits and synergies associated with the concurrent use of scalp acupuncture and physiotherapy in the treatment of ARSACS.

Data availability statement

All data generated or analyzed during this study are included in this published article and its supplementary information files.

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Ethical approval

This study was reviewed and approved by the IMU University Joint-Committee (IMU-JC) with the approval number: BCM I-2022 (07), dated September 29, 2022. Informed consent was acquired from the patient/guardian and the patient/guardian consented to the publishing of all images, clinical data, and other data included in the manuscript.

CRediT authorship contribution statement

Kim Sia Sng: Writing – original draft, Visualization, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Yen Suan Sin:** Supervision, Conceptualization. **Salma Musallam O. Alhawiti:** Writing – review & editing, Methodology, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e33046.

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