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Effects of Synergy between Physiotherapeutic Resources as a Systemic Intervention Model on the Quality of Life of Patient with Autism-Case Study

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Abstract

Autism Spectrum Disorder (ASD) are changes in neurological development that manifest in childhood, with greater or lesser intensity, and impair the ability to communicate and relate. Its etiology is still unknown, but studies state that the association between genetic, environmental and neurological factors influence the development of this disorder, being directly related to changes in the intestinal microbiota. The characteristics of ASD are: changes in the gastrointestinal tract, possible seizures, self-harm and sleep disorders due to anxiety, hyperactivity, gastroesophageal reflux, among others. The objective of this case report was to observe possible changes in the reduction of anxiety and improvement of sleep quality through the action of photobiomodulation and ultrasound. It was carried out with 1 patient with Autism Spectrum Disorder (intellectual disability), male, 12 years old, at the Photodynamic Therapy Unit of Santa Casa de São Carlos. The equipment used was RECUPERO®, capable of emitting laser and ultrasound. The application was performed during 10 sessions, on the palms of the hands, totaling 10 minutes on each hand (20 minutes in total). The ultrasound is used in continuous mode, with an intensity of 0.8w/cm^2, with 1MHz and the therapeutic laser (photobiomodulation) at wavelengths of 660nm and 808nm. The mechanisms for evaluating progress are: Autism Treatment Assessment, Childhood Autism Assessment Scale, Assessment of Anxiety and Depression Levels and the Pittsburgh Sleep Quality Index. The results evaluated were positive for reducing anxiety and improving sleep quality, which optimizes the overall condition of these patients. This innovative, non-drug and non-invasive proposal is a resource that provides numerous benefits for the health and quality of life of these individuals.

Keywords: Autism; Laser; Ultrasound; Anxiety; Sleep

Introduction

Autism Spectrum Disorder (ASD) is a neurological development disorder that can range from mild to severe, characterized by behavioral problems that include hyperactivity, difficulty paying and/or maintaining attention, hyperselective attention, impulsivity, aggressive and self-destructive behavior, sleep disorders, physical limitations, and social isolation [1,2]. Some neuroimaging and autopsy studies indicate brain abnormalities in individuals with ASD, such as: abnormal sizes of the amygdala, hippocampus, and corpus callosum, delayed maturation of the frontal cortex, stunted development of neurons in the limbic system, and varied patterns of low activity in different brain regions, such as the frontal cortex and limbic system [2]. The most common characteristics of ASD are: changes in the gastrointestinal tract, possible seizures, self-harm, and sleep disorders, such as difficulty initiating sleep, sleepwalking, and frequent nightmares [3]. The reduction in hours of sleep results in endocrine and metabolic changes, which influence homeostatic control, that is, a decrease in the secretion of anorexigenic hormones, such as leptin, to the disadvantage of an increase in orexigenic hormones, such as ghrelin, resulting in disturbances in food consumption and glucose tolerance and insulin secretion, which when altered influence the accumulation of energy due to insulin resistance [2,4].

The etiology of ASD is still unknown, but studies claim that the association between genetic, environmental and neurological factors influence the development of this disorder [3]. Genetic factors are related to the difference in parental age and genetic inheritance, while environmental factors are linked to maternal stress, diet, medications for maternal diabetes and diseases, a diet poor in nutrients or with a high level of neurotoxic foods, maternal or infant infections, which can lead to dysbiosis, use of analgesics and antibiotics, which alter the development of the intestinal microbiota, pollution, gestational age, indicating that the more premature the baby is, the lower the maturation of the brain-intestinal axis, route of delivery, with vaginal delivery being responsible for part of the formation of the newborn's microbiota through direct contact with the maternal vaginal and intestinal microbiota and the type of postnatal nutrition [2,3]. Regarding neurological factors, it was analyzed that approximately 40-60% of patients with ASD have changes in the gastrointestinal tract, such as frequent abdominal pain, diarrhea and constipation, which are directly related to changes in their intestinal microbiota [3]. These changes in the intestinal microbiota occur as a consequence of intestinal dysbiosis, which is an imbalance in the microbiota, resulting in increased intestinal permeability, which allows the entry of pathogens, inadequately digested nutrients and toxins through the intestinal mucosa, which reach the bloodstream and the blood-brain barrier, resulting in cognitive and behavioral changes

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[3,4]. Dysbiosis prevents the intestine from efficiently producing short-chain fatty acids (SCFA), which can cause mitochondrial dysfunction through metabolic pathways [4]. The presence of SCFA in the intestine occurs through the fermentation of the microbiota, which is necessary for the host, but an excess of some SCFA can affect the central nervous system, resulting in neurological symptoms [3]. Certain SCFAs exert a very important influence on brain mitochondria, such as acetate, which is used as an energy source; butyrate, which stimulates mitochondrial biogenesis and has a bioenergetic function [4].

The connection between the brain and the intestine occurs through the vagus nerve, a region that manifests changes in a bidirectional manner, leading to pathologies such as: ASD, Parkinson's, depression, schizophrenia and chronic pain, due to the release of metabolites from the intestinal microbiota that affect intestinal impermeability, immune function and mucosal sensitivity, and the release of hormones and gastrointestinal neurotransmitters. Serotonin, a neurotransmitter involved in the brain- intestinal axis, is responsible for modulating neurodevelopment, acting on social functions and repetitive behaviors, and in ASD there is an increase in some intestinal bacteria, for example Clostridium and Lactobacillus, which influence serotonin dysfunction [3].

The DSM-V (Diagnostic and Statistical Manual of Mental Disorders) describes ASD as Level 1 - Mild (little support): presents apparent difficulty in communication and there is no limitation for social interactions; Level 2 - Moderate (needs support): presents greater difficulty in communication and language deficiencies; and Level 3 - Severe (needs more support): presents greater deficit in verbal and nonverbal communication skills, reduced cognition and difficulty in social interactions. In the ICD (International Classification of Diseases and Related Health Problems)-11, ASD is described as: 6A02.0 - Autism Spectrum Disorder without Intellectual Disability (ID) and with mild or absent functional language impairment; 6A02.1 - Autism Spectrum Disorder with ID and with mild or absent functional language impairment; 6A02.2 - Autism Spectrum Disorder with ID and with impaired functional language; 6A02.3 – Autism Spectrum Disorder with ID and with impaired functional language; 6A02.5 –Autism Spectrum Disorder with ID and with absent functional language; 6A02.Y-other specified autism spectrum disorder; 6A02.Z – Autism Spectrum Disorder, unspecified [5].

Studies indicate an increase in the prevalence of ASD, in the period between 2000 and 2010 it was identified that the number of diagnoses doubled, increasing from 6.7 to 14.7 for every 1000 children under eight years of age, in 2017 there was another significant increase, being 1 in every 68 children [6].

Treatment for ASD includes pharmacotherapy, with the most commonly used drugs for these children and adolescents being neuroleptics, including risperidone, which improves irritation, hyperactivity and stereotypies, with side effects including weight gain, sedation, increased appetite, agitation and sleep disorders [7].

Other pharmacological classes used are selective serotonin reuptake inhibitors, mood stabilizers and benzodiazepines, with side effects such as weight gain, due to the increase in appetite that is related to the blocking of H1 receptors by drugs in this class [8].

Another treatment for ASD is cognitive-behavioral therapy, such as neuropediatric physiotherapy and psychopedagogy, areas that use methods and techniques that make the autistic person develop functionality, skills and obtain knowledge, together with the need for parental involvement to obtain satisfactory and more promising results in the rehabilitation of the person involved [9,10].

Pharmacological treatment of ASD can lead to side effects and adverse reactions. Furthermore, cognitive behavioral therapy is a strategy with long-term effects. Therefore, many researchers have proposed new therapies, preferably non-invasive and with low cellular toxicity, with immediate effects such as photobiomodulation, with transcranial application, using LEDs and Laser, which consists of a spectrum of light between red and infrared, applied to various anatomical points, with different fixation and irradiation points. Studies have considered this therapy safe and effective in reducing ASD symptoms, but with some side effects such as headache [11-13].

Low-intensity laser therapy, also called photobiomodulation, is produced by producing red and infrared light, which is absorbed by photosensitive structures such as cytochrome C oxidase, a unit of the mitochondrial respiratory chain. This results in an increase in electron transport, mitochondrial membrane potential and production of adenosine triphosphate (ATP). Ion channels are photosensitive and, when absorbing photons, increase the concentration of intracellular calcium ions [14]. The absorption of the light stimulus by cytochrome C chromophores generates a response for each type of lesion that is exposed to light, which results in the release of histamine, serotonin, bradykinin and prostaglandins, resulting in a reduction in pain, inflammation and tissue repair [15].

In addition to low-intensity laser therapy, there is another therapeutic method known as therapeutic ultrasound, which is non-invasive and consists of a device made of piezoelectric crystals. In this method, electrical energy is transformed into oscillatory mechanical energy through high-frequency alternating currents [14]. These are longitudinal waves with deep penetration that dissipate over biological tissues, which produces cellular changes due to mechanical effects [15]. The waves mechanically deform the tissue molecules, which results in friction and heat production. These thermal and non-thermal effects induce biological responses such as muscle relaxation and, like low-intensity laser, tissue regeneration and reduced inflammation. In addition, therapeutic ultrasound allows greater ionic permeability due to the cavitational effect, positively influencing the increase in nerve stimulation when applied in conjunction with low-intensity laser [14].

The synergistic association between therapeutic laser and therapeutic ultrasound is achieved through a device called Recupero®, which allows the simultaneous overlapping of the fields of action of the therapy. In this form of combined laser and ultrasound therapy, it was observed that application to the palms of the hands, in the Thenar, Hypothenar and Aponeurosis regions, with a large number of nerve endings and blood vessels, resulted in an increase in ionic permeability (provided by ultrasound), production of ATP through photobiomodulation, in addition to anti-inflammatory action. There is a systemic homeostatic function, in which the nerve conduction of stimuli through afferent pathways to the brain allows the reduction of intracranial pressure, positively affecting the pain center near the prefrontal cortex. The systemic action extends to other regions through the systemic parasympathetic system (vagus nerve), producing bradycardic effects [16].

The RECUPERO® device has also been used for cases of fibromyalgia, psoriatic arthritis, rheumatoid arthritis, osteoarthritis, post-Covid 19 sequelae, temporomandibular dysfunction, pain, weakness, paresthesia, respiratory condition, memory, smell and taste and osteoarthritis [14-17].

Thus, systemic photobiomodulation and ultrasound therapy

performed on the palms of the hands may be a promising and innovative strategy in ASD, contributing to reducing anxiety and improving sleep quality in individuals with autism.

Materials and Methods

The present study was submitted to the Research Ethics Committee for Human of Irmandade da Santa Casa de São Carlos Hospital, C.A.A.E no.84717224.1.0000.8148. The parents signed the Free and Informed Consent forms, in which the objectives and procedures necessary for the execution of the research were explained. This work is a case report of a patient with a medical diagnosis of Autism Spectrum Disorder, ICD 10- F84.0 (childhood autism) with ICD 10-F72 (intellectual disability), male, 12 years of age, using atypical antipsychotic and anticonvulsant medications. In a school behavioral report, provided by the São Paulo State Department of Education, in October/2024, the following episodes were reported as observed prior to the proposed intervention: self- harm, lack of sphincter control, defiant-oppositional behavior, excessive shouting and agitation and restlessness.

The treatment was performed at the Photodynamic Therapy Unit at the Irmandade da Santa Casa de Misericórdia de São Carlos, a clinical research unit in partnership with the Instituto de Física de São Carlos. The combined low-intensity laser and therapeutic ultrasound equipment (RECUPERO®) was used for 10 treatment sessions, distributed over 4 weeks of treatment. The application was performed on the palms of the hands, for a total of 10 minutes on each palm, in the region of the palmar aponeurosis, making slow, circular movements with the head, using gel on the interface. The parameters used in the ultrasound are: continuous mode, frequency 1MHZ, intensity of 0.8w/cm2; low-intensity laser with wavelengths of 660nm and 808nm. To begin the sessions, the patient was instructed to wear protective glasses to block the broad spectrum of light.

To assess the patient's results and progress, the Autism Treatment Assessment (ATEC) was used: a tool that measures the effectiveness of treatments for ASD; the Childhood Autism Rating Scale (CARS): an assessment tool that helps identify and diagnose children with autism; the Anxiety and Depression Rating (HAD): used both for diagnostic screening and to measure the severity of the disorder; and the Pittsburgh Sleep Quality Index: assesses sleep quality in a multidimensional way. All assessments were performed before and after treatment (10 sessions).

Results

Figure 1 demonstrates, through the Pittsburgh Sleep Quality Index Assessment, a reduction between pre-treatment (value 12), in relation to post-treatment (value 9).

In Figure 2, the Anxiety and Depression Level Assessment (HAD)

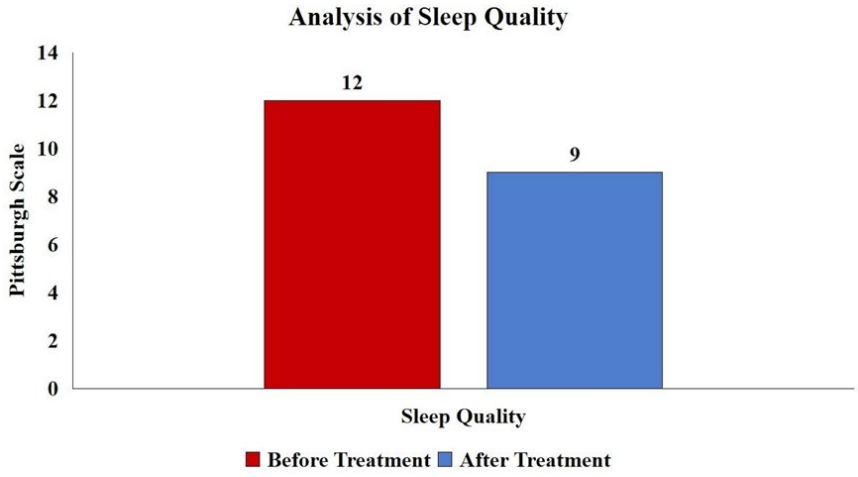

Figure 1: Comparison of effect of laser and ultrasound application in relation to the sleep quality, according to Pittsburgh scale, before and after treatment of autism case.

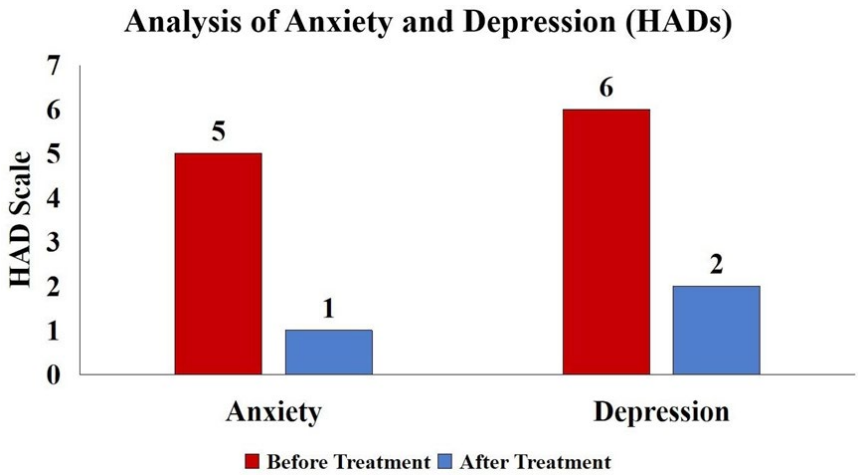

Figure 2: Comparison of effect of laser and ultrasound application in relation to the anxiety and depression levels, according to hospital anxiety and depression scale, before and after treatment of autism case.

shows a reduction in values, for the HAD Anxiety Scale in pre-treatment (value 5), in relation to post- treatment (value 1) and for the HAD Depression Scale in pre-treatment (value 6) in relation to post-treatment (value 2).

In Figure 3, which shows the use of the autism analysis instrument called "Autism Treatment Assessment (ATEC)", there is a reduction in pre-treatment values (value 71), in relation to post-treatment (value 46), indicating the reduction in values through the intervention model carried out.

In Table 1, the Childhood Autism Rating Scale (CARS) is used, which indicates a reduction in some items such as: Body use in pre-treatment (value 3) and post-treatment (value 2); Visual response in pre-treatment (value 3) and post-treatment (value 2) and in the Activity level in pre-treatment (value 4) and post-treatment (value 2), obtaining a total result in pre-treatment (value 48) and post-treatment (value 43.5).

Discussion

Studies indicate a significant increase in the prevalence of ASD in 2017, with 1 in every 68 children [6]. The etiology of ASD is still unknown, but studies state that the association between genetic, environmental and neurological factors influence the development of this disorder. Its main characteristics are changes in the gastrointestinal tract, possible seizures, self-harm, difficulty in communication and social interaction, anxiety, depression and sleep disorders, such as difficulty initiating sleep, sleepwalking and frequent nightmares [3].

These characteristics are the main challenges faced by individuals with autism and their families, and it is important to promote new approaches that help improve the clinical condition, bringing benefits such as reducing anxiety and improving the quality of sleep [3].

Previous studies using photobiomodulation and ultrasound therapy report reduced anxiety and improved sleep quality [16,18]. The studies promoted long-term monitoring of fibromyalgia patients, as well as the comparison of patients with sleep disorders, with or without the use of controlled medication, allowing the monitoring of the evolution of anxiety, depression and sleep quality through the use of technology that uses light and ultrasound [16,18]. Furthermore, like other studies with positive results using photobiomodulation and ultrasound therapy, it was observed in individuals affected by fibromyalgia, psoriatic arthritis, rheumatoid arthritis, osteoarthritis,

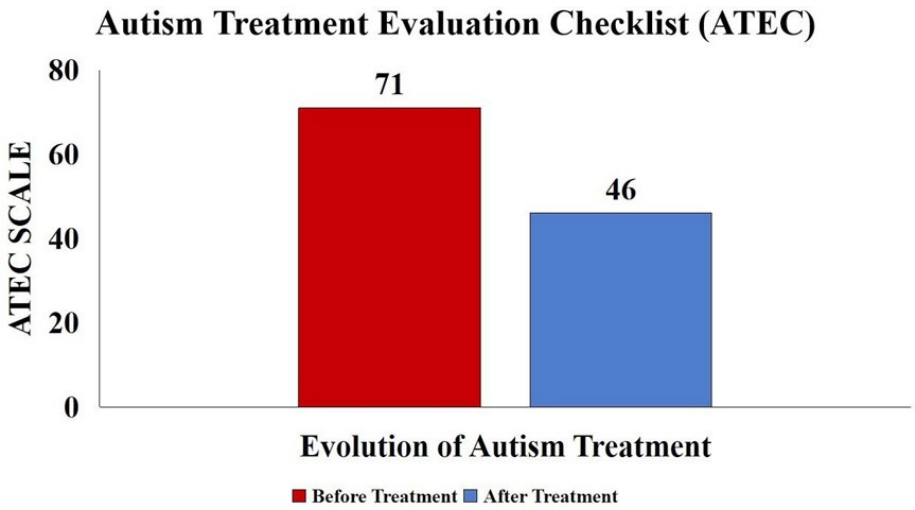

Figure 3: Comparison of effect of laser and ultrasound application in relation to the anxiety and depression levels, according to autism treatment evaluation checklist, before and after treatment of autism case.

Table 1: Childhood autism rating scale-CARS.

Childhood Autism Rating Scale-CARS		
	Before Treatment	**After Treatment**
Personal Relationships	3	3
Imitation	3	3
Emotional Response	2	2
Body Use	3	2
Use of Objects	2	2
Response to Changes	3	3
Visual Response	3	2
Auditory Response	3	3
Response and Use of Taste, Smell, and Touch	2	2
Fear and Nervousness	3	3
Verbal Communication	3	3
Nonverbal Communication	2	2
Activity Level	4	2
Level and Consistency of Intellectual Response	2	2
Total	**48**	**43.5**

post-Covid 19 sequelae, and temporomandibular dysfunction [14-17].

As a hypothesis for the present study, we have that the systemic application of photobiomodulation and ultrasound in the palms of the hands allows the conduction of these resources, duly absorbed by the nerve endings and peripheral circulation, through the afferent pathways, to the central nervous system. Occurring at this point, the regulation of intracranial pressure (brain compliance), allowing such modulation to positively influence the prefrontal cortex, where it gradually regulates the pain threshold, offering analgesic and anti-inflammatory action, stimulation of photoreceptors, enzymes and production of ATP such as adenosine triphosphate, release of histamine, serotonin, bradykinin and heparin, and also results in the reduction of anxiety and sleep regulation [14,18]. These results are confirmed by observing figures 2 and figure 3, respectively of sleep quality and anxiety and depression. There is a visible improvement in the condition, of the variables mentioned. Furthermore, as a direct indication of the improvement of these variables, Figure 4 represents the values obtained according to the Autism Treatment Evaluation Check List, which illustrates the quality of life and change in the complexity of ASD. The values obtained, reducing from 71 to 46, through intervention, show the effect of reducing anxiety and depression and improving sleep quality, indicated in a specific instrument for the spectrum evaluated. Furthermore, Table 1, which shows the measurement of the Childhood Autism Assessment Scale (CARS), also indicates an improvement, reducing from 48 to 43.5, positively directing the intervention model.

Thus, we observed positive results in the variables anxiety and sleep quality, resulting in improvements in aspects involving the reduction of self-aggression, irritability and eating, as well as increased focus on activities and sociability. Furthermore, the school behavioral report shows that during the proposed intervention period, referred to in the report simply as photobiomodulation, although it was combined with ultrasound, there was a significant improvement in all behavioral aspects, reducing episodes of self- aggression and behavioral resistance, as well as sphincter control.

Conclusion

Based on the results presented, it is possible to observe, for this patient and his family, an improvement in the quality of sleep, and a decrease in anxiety and depression levels. Thus, these findings demonstrate the satisfactory evolution of the clinical picture of the autism spectrum due to improved functionality, suggesting the effectiveness of the proposed treatment, which innovates by providing a non-drug, non-invasive resource with numerous health benefits.

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