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THE BENEFITS OF EARLY STIMULATION ON THE MOTOR DEVELOPMENT OF A FIVE-MONTH-OLD CHILD UNDERGOING AORTIC COARCTATION SURGERY

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Abstract: Coarctation of the aorta is an acyanotic congenital anomaly defined by a narrowing of the aortic artery. People with congenital heart disease are more likely to develop motor delays. In addition, invasive procedures carried out in early childhood have a negative impact on children's cognitive and motor development. The aim of this scientific study was to demonstrate the benefits of early stimulation on the motor development of a five-month-old child who had undergone aortic coarctation surgery. The relevance of this research lies in the fact that congenital heart disease ranks first among congenital malformations, has a high morbidity and mortality rate, and coarctation of the aorta is the fifth most common heart disease, causing a series of cardiorespiratory disorders and impairments in neuropsychomotor development. This is a clinical case study, with a qualitative approach, of a Brazilian participant, from Ithaperun, an infant, aged five months, male. The interventions took place between March and August 2024, weekly, lasting 50 minutes each. Motor Kinesiotherapy Techniques, Sensorimotor Training, Manual Therapy, Surface and Deep Sensory Stimulation, Thoracic-Abdominal Rebalancing Techniques, Acceleration of Rapid and Slow Expiratory Flow and Slow and Prolonged Expiration were applied. The patient obtained significant therapeutic response to the treatment plan outlined, achieving important milestones in May 2024, such as free sedestation and transfer from dorsal to ventral decubitus (rolling); in June, he acquired the four-legged and bipedal postures, and the "rocking" and "pivoting" movements; in July, he began to crawl and in August, he reached functional kinetic milestones, such as transferring from the sedestation, side sitting, kneeling and bipedal postures, as well as free orthostatism sustained for 5 seconds, which brings his motor age into line with his chronological age. The results of this study showed that early stimulation, being a transdisciplinary clinical therapeutic intervention, proved to be a valuable tool for acquiring skills, adjusting developmental milestones and optimizing healthy motor performance.
Keywords: Early stimulation, Motor development, Coarctation of the aorta.

INTRODUCTION

Congenital heart defects are pathological structural and/or functional alterations of the cardiac system and large intrathoracic vessels. The anomalies appear during the formation of the cardiovascular system, the 3rd and 4th weeks of gestation. They are classified as acyanotic, characterized by overload of the volume or pulmonary pressure; or cyanotic, identified by having a right-left shunt and cyanosis (CORREA et al., 2023). Among the congenital heart diseases is coarctation of the aorta, classified as acyanotic, defined by the narrowing of the aortic lumen, which can be single or multiple and occur anywhere along the course of the aortic artery. Depending on the level and extent of the lesion, coarctation can lead to serious hemodynamic disorders, which requires an emergency surgical procedure (AUDI et al., 2023).

The etiology of coarctation of the aorta, as well as congenital heart disease, is idiopathic. However, some environmental and genetic factors may be associated with the genesis of heart disease, including maternal factors such as pregnancy after the fourth decade of life, diabetes mellitus, low nutritional status, alcoholism, radiation, rubella, use of anticonvulsant medication, lithium and isotretinoin. However, these are hypotheses, which have not yet been confirmed (GALVÃO et al., 2021). Epidemiological data reports an incidence of congenital heart disease in approximately 0.8 to 1% of live births, with 20 to 30% of these individuals dying, which represents a very significant level of mortality. Coarctation of the aorta accounts for around 6 to 8% of cases of congenital heart disease and is more prevalent in boys (CARVALHO et al., 2021).

The main clinical sign of coarctation of the aorta is arterial hypertension in the upper limbs, while the lower limbs show arterial hypotension. Tachypnea, fatigue and difficulty in gaining weight can also be found (JONAS, 2004 in: DEUCHER JUNIOR, 2021). The diagnosis of coarctation of the aorta is mainly made by echocardiography, as it allows anatomical and physiological analysis of the heart chambers and can be performed during pregnancy or after birth (MORHY et al., 2020).

A child's first 1,000 days, from conception onwards, are marked by an exorbitant number of synapses, which are fundamental for the acquisition of motor, cognitive, social and emotional skills. (VELHO & CARDOSO, 2020). In addition, the ability to roll over, sit, walk and acquire new motor skills is achieved through the synergy between muscle contraction and biomechanical adjustment, passively shaped by the exploration of the environment and external stimuli (OLIVEIRA & FRANCO, 2020). The surgical treatment of aortic coarctation can cause damage to the cardiopulmonary system and a deficit in the neuropsychomotor development of infants and children, corroborating the delay in motor milestones, which makes it extremely relevant for physiotherapy to work as part of a multi-professional team in the treatment of these patients (MELO et al., 2021).

Early stimulation is a strategy that applies a variety of motor and sensory stimuli to attenuate and/or correct disturbances in neuropsychomotor development. By analyzing chronological age and adjusting the corresponding performance, with global organization, improved tone, inhibition of inappropriate movements and postures, prevention of deformities and dysfunctions, directing the child towards acquiring their genetic potential, it promotes gains in the physical, social and emotional spheres (SOUZA et al., 2022). It is essential that early stimulation is started as soon as possible, since neuroplasticity occurs in its most expressive form in early childhood. In addition, when associated with the application of playful activities, early stimulation achieves better outcomes, adding greater physical conditioning and adherence to treatment, caused by carrying out activities in a light and pleasant way, with the application of techniques that correlate play and/or sports in a playful way (DELVALLE et al., 2021).

Through frequent early stimulation, it is possible to optimize motor and social activities that act inversely to the harmful repercussions of delayed motor milestones. Seeking the active participation of children and their families, stimulation should be dynamic and attractive, contributing to experiences that lead to learning, social gains, language and motor training (RAMOS & MULLER, 2019). Achieving child development compatible with chronological age, early stimulation has an extremely positive influence on the lives of infants, since early stimulation increases the number and capacity of synapses, favoring the event of neuroplasticity and corroborating the improvement of neuropsychomotor development (CABRAL et al., 2020).

The relevance of this research is based on the fact that aortic coarctation and its corrective surgical procedure are predisposing factors to the emergence of delays in neuropsychomotor development, due to various factors such as: nutritional deficiency of tissues and organs, prolonged period of hospitalization, post-surgical cardiopulmonary complications, among others, the proposed study can help physiotherapist professionals, emphasizing the relevance of their assertive action, of adequate physiotherapeutic diagnosis, identifying possible dysfunctions consistent with motor milestones and of early intervention, for a better prognosis, making the most of the peak of neuroplasticity, since physiotherapeutic intervention, through constant stimulation, is capable of attenuating and/or extinguishing deficits in motor milestones,

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optimizing their functionality, enabling them to reach their maximum genetic potential, guaranteeing more independence and quality of life for the patient. These conditions plausibly justify the urgent need for studies on the subject.

The aim of this scientific study was to demonstrate the benefits of early stimulation on the motor development of a five-month-old child who had undergone aortic coarctation surgery.

Figure 1 - Expiratory Flow Acceleration. Source: Personal collection.

Figure 2 - Scar release. Source: Personal collection.

Figure 3 - Postural training in sedation. Source: Personal collection.

Figure 4 - Vibratory sensory stimulation. Source: Personal collection.

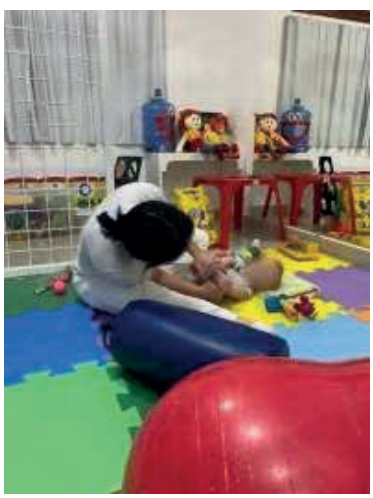

Figure 5 - Decubitus transfer. Source: Personal collection.

Figure 6 - cervicodorsal muscle tension.

Source: Personal collection.

Figure 7 -Static balance training.

Source: Personal collection.

Figure 8 - Fine praxis activity.

Source: Personal collection.

METHODOLOGY

The methodology of this scientific trial was a clinical case study, with a qualitative approach, of a Brazilian participant, from Itaperuna, who was a five-month-old male infant with delayed motor development due to a clinical diagnosis of coarctation of the aorta and corrective surgery for heart disease at 7 days of age. The physiotherapy treatment sessions were scheduled and carried out at the Physiotherapy School Clinic of Universidade Iguaçu - Campus V, located in Itaperuna - RJ, at Rua Alfredo Crespo Martins, number 116, in the Cidade Nova neighborhood. The interventions took place between March and August 2024, totaling 21 uninterrupted sessions, held weekly and lasting 50 minutes each.

During the sessions, Motor Kinesiotherapy Techniques were applied to provide muscle stretching, joint mobilization and strengthening; Sensory Motor Training, optimizing tonic dialogue and stimulating postural positions consistent with the motor milestones aimed for; Manual Therapy Technique, promoting the realignment of scar fibers, minimizing adhesions; Superficial and Deep Sensory Stimulation, improving communication between the afferent and efferent pathways of the techniques that help to reorganize the thorax and abdomen geometrically and synchronously during the respiratory cycle; Rapid and Slow Expiratory Flow Acceleration Techniques; as well as Slow and Prolonged Expiration, as auxiliary alternatives for removing and eliminating tracheobronchial secretions. In order to apply the techniques, auxiliary resources such as the Bobath ball, foam triangle, educational toys, proprioceptive balls, audiovisual resources and mechanotherapies such as the vibrating platform were incorporated into the sessions. Care was provided through verbal guidance and tactile stimulation, in a playful way, with psychomotor activities.

The therapeutic protocol used integrated techniques and methods from respiratory physiotherapy, manual therapy, sensory stimulation, motor physiotherapy and psychomotricity, which are discussed below.

Passive muscle stretching of the accessory muscles of breathing, stretching the muscle fibers, distancing the origin from the musculotendinous insertion, performed on the sternocleidomastoid, anterior, middle and posterior scalene and intercostal muscles, increasing the flexibility of these muscles, which provides greater capacity for extension of the muscle fibers and expansion of the chest, optimizing lung ventilation.

Thoracic-abdominal rebalancing, the mobilization of the sternocostal joint is done with a circular movement on the sternum bone, with a slight pressure, improving the intra-articular range of movement, avoiding or reducing joint stiffening, which limits mobility and restricts the expansion of the costal gradient during the inspiratory phase.

Thoracic-abdominal rebalancing, thoracic-abdominal support technique, one hand is positioned on the abdominal region, with the first and second finger on the last costal arches, to feel the phases of the respiratory cycle, while the other hand is positioned on the intermammary line. A small amount of compression is applied, maintained for a few respiratory cycles (on average 3 cycles), then the hands are removed and the baby breathes freely for a few breaths. cycles, so as not to fatigue. The technique stimulates thoracic-abdominal reorganization, promoting synchronized expansion during inspiration.

Accelerating the expiratory flow slowly and quickly, one hand is positioned over the umbilical scar, with the first and second fingers over the last costal arches, feeling the respiratory cycle, while the other hand is positioned between the sternal furcula and the intermammary line, wrapping around the side of the chest. During the expiratory phase, the hands should move in an oblique and synchronized movement, one against the other. The manoeuvre increases expiratory airflow, mobilizing tracheobronchial secretion and facilitating its removal. When the slow expiratory flow acceleration maneuver is performed, the secretion is mobilized from the smaller to medium-caliber airways, reaching more peripheral areas of the lung, while in the fast mode, the secretion is carried from the medium to large-caliber airways, so the secretion is mobilized from the more distal lung segments to the central region of the bronchial tree, allowing it to be expectorated using bronchial hygiene techniques, such as coughing or tracheal aspiration.

Slow and prolonged expiration, with the hands positioned on the baby's chest and abdomen, a light compression is performed, starting at the end of the expiration, maintaining the position for 2 or 3 attempts to inhale the baby, promotes a reduction in lung volumes towards the residual volume, that is, it enhances the maximum emptying of the lung, optimizing the expiratory volume.

The respiratory physiotherapy techniques used provide mobilization of tracheobronchial secretions, maintaining airway patency; they improve thoraco-abdominal synchrony during the respiratory cycle, consequently optimizing pulmonary ventilation and hematosis, which contributes to reduced fatigue during exercise, better energy reserve and tissue oxygenation, fundamental factors for satisfactory motor training results.

Manual scar release, with the technique of superficial and deep sliding, applied in the direction of the chain of muscle fibers, it is possible to while transverse friction, performed with movement in the transverse direction of the fibers, stimulates collagen synthesis and realignment of the fibers. The Cyriax technique is applied as a deep transverse massage, without the use of gliding agents such as oil, and is capable of minimizing scar adhesions with the formation of disorganized fibrotic tissue.

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Release promotes realignment of disorganized scar fibers, reduces tissue adhesion, allowing organic tissues to slide over each other, providing greater range of motion of the proximal joint, in this case the left shoulder, since the scar is located in the left dorsal posterolateral region, making release essential for gaining mobility and acquiring new motor skills in the upper limb.

Superficial, tactile sensory stimulation was carried out with acral stimulation, using objects with different textures. The deep, vibratory stimulation was carried out on the vibrating platform for a period of 5 minutes. The aim is to activate various afferent pathways, improving the respective motor responses.

Sensory stimulation favors the alignment and synchrony of afferent and efferent pathways, since it helps to adapt motor responses to different sensory stimuli, optimizing the execution and quality of movements, which are important for gains in motor skills.

Passive joint mobilization, arthrokinematic mobilization, such as micro-movements of sliding, traction, rolling, compression and rotation, performed on the large joints of the body, helps produce synovial fluid and improves intra-articular range of motion, which prevents and/or rehabilitates joint stiffness and contractures. Osteokinematic mobilization involves physiological movements of the joint in relation to the main cardinal planes of the body, such as flexion, extension, abduction, adduction, external and internal rotation, among others. The combination of the two techniques improves joint range of motion.

Passive stretching of the muscle chains, extension of the muscle fibers of the anterior, lateral and posterior chains, respecting mechanical and painful limits, promotes muscle relaxation and optimizes flexibility, consequently increasing the range of movement, with an increase in the angulation of the movement performed between the body segments.

Dissociation of girdles, with rotational movement of the pelvic and scapular girdles, in different directions, simultaneously, maintained for 20 seconds. It facilitates movements such as crawling and marching, which require rotational movement of the trunk and alternating body dimensions.

Passive kinesiotherapy in a crossed kinetic chain involves flexion/extension of the shoulder and elbow simultaneously with flexion/extension of the hip and contralateral knee, in a passive manner, with the aim of stimulating motor learning, fixing in permanent memory the movement that will help develop the crawling milestone.

Postural training, exercises to stimulate the puppy, sphinx, sedestation, four-legged and bipedestation postures, as they comprise important motor milestones for the acquisition of functional skills; the achievement of one milestone is extremely important and the basis for the acquisition of the next.

Decubitus transfer involves changing from one posture to another. From the supine position to the lateral and ventral positions (rolling over) and vice versa, is an important achievement that facilitates mobility and reach. From lateral decubitus to sedestation helps the baby achieve greater independence, enabling them to change to desired postures. From sedestation to four-poster makes it easier to move around and reach distant objects.

An activity to stimulate the manual protective reaction of balance, it consists of stimulating active movement of the baby's hands and anterior, lateral and posterior positioning in relation to the body. It is a protective measure against falls and provides greater independence for the baby and safety for the parents.

Global strengthening involves applying a load greater than the patient's level of muscle function. It can be used to support the body's own mass, especially the trunk stabilizing muscles, such as the CORE muscles (biceps

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femoris, transverse abdominis, multifidus, adductors, erector spinae, internal and external oblique, iliopsoas, gluteus maximus and rectus abdominis); antigravity muscles, which enable bipedal posture; large muscle groups in the upper and lower limbs. Myofibrillar hypertrophy is characterized by an increase in muscular effort, due to the contraction of myofilaments. It is indicated for gaining functional strength, in which case there is no increase in muscle mass, but rather in strength for performing functional movements, which are fundamental for acquiring more complex, demanding and combined skills.

In tummy time, the baby is positioned in a prone position on the tatami mat, which strengthens the cervical and dorsal muscles, as well as helping to acquire the puppy and sphinx motor milestones. In sedestation on the Bobath ball (a 45cm ball was used), the baby has the experience of contact on an unstable surface, which stimulates the strengthening of the axial muscles and tonic dialogue, in which the baby needs to adjust muscle tone as their position is destabilized.

Motor training prepares and conditions the body's systems, providing strength, balance, motor coordination and proprioception, fundamental factors for acquiring new skills and achieving future motor milestones, which in turn positively influences cognitive, psychosocial and language elements, relevant skills for carrying out daily, school and leisure activities.

This activity stimulates recognition of the body schema. The baby is positioned in front of a mirror and is shown the component parts of their own body, helping them to touch and see their nose, ears, hair, feet and other parts and associate them with the corresponding name. Facilitates learning to recognize the elements of the body, their positioning and the assimilation of names, optimizing the recognition of their own body.

Active exercise to stimulate spatial orientation and broad and fine motor coordination. In sedestation, the child is positioned parallel to a box containing objects and is encouraged to remove and put the objects back in the box, performing broad movements of the upper limbs (global motor coordination), minute movements of the palmar grasp (fine motor coordination), as well as demanding an understanding of which objects fit in the box (spatial orientation), important skills for performing functional activities typical of their age.

Static and dynamic balance training, in sedestation and bipedestation, with static posture and stimuli that promote the execution of movements, the child is motivated to keep the body mass within the support base and the body within its cone of stability, overcoming gravity and shaping their posture in the face of destabilizing external forces, essential activities for locomotion.

Activity with sound and visual stimulation and motor response, in sedestation, the child receives lateral audiovisual stimulation (pedagogical toy), which optimizes motor eye tracking, hearing, cervical and trunk rotation, which will later act as facilitators for the recognition of left and right lateralization.

Fine praxis exercises involve manipulating objects, grasping and pincer movements, picking up small objects and removing adhesive tapes from nearby surfaces. Optimizing fine praxis skills, which are fundamental for the acquisition of manipulative and writing tasks.

Psychomotricity favours the acquisition and enhancement of psychomotor elements such as cognition, muscle tone, broad and fine motor coordination, balance, laterality, lateralization, spatial and temporal orientation, body image and body schema, which are key factors for full and coordinated control of movements and the achievement of subsequent motor milestones.

RESULTS AND DISCUSSIONS

At the first therapeutic assessment, on 28/02/24, the patient, at five months of age, had cervical balance, oculo-motor screening and puppy posture, milestones consistent with the third month of life, showing a significant delay in achieving motor milestones, with a two-month deficit in motor age in relation to chronological age, this analysis was based on the Ministry of Health's motor development indicators for children aged zero to three years, recommended by the 2016 Early Stimulation Guidelines.

The protocol used included respiratory and motor kinesiotherapy, manual therapies, sensory stimulation and psychomotor activities, which optimized tone, strength gain, balance and coordination, reflecting positively on neuropsychomotor development. Breathing exercises, which boost tissue and organ oxygenation and muscle nutrition, helped to provide an adequate motor response to the stimuli offered. Sensory stimulation, which optimizes synchrony between afferent and efferent pathways, improved movement execution and control. Manual therapy made it possible to reduce the post-lateral tissue adhesion in the trunk, which limited the physiological range of the left upper limb, restoring its joint functionality. Postural, transfer, global strengthening, resistance, balance and proprioception training, combined with psychomotor activities, enabled the acquisition and improvement of motor skills, allowing the motor age to be adjusted to match the chronological age, offering the patient greater functionality, autonomy and quality of life.

The results obtained demonstrated the efficiency and effectiveness of the therapeutic intervention and follow-up program of early stimulation applied to patients undergoing aortoplasty surgery due to coarctation of the aorta, in a relatively short period of time, between 13/03/24 and 07/08/2024, totaling 21 sessions, the patient achieved a significant therapeutic response to the treatment plan outlined, reaching important milestones in May 2024, such as free sedestation and transfer from dorsal to ventral decubitus (rolling); in June, he acquired the four-legged and bipedal posture, and the "rocking" and "pivoting" movements; in July, he began to crawl and in August, he reached functional kinetic milestones, such as transferring from the sedestation, side sitting, kneeling and bipedal postures, as well as free orthostatism sustained for 5 seconds, which brings his motor age into line with his chronological age.

According to Santos, Dantas and Oliveira (2004) neuroplasticity reaches its peak in the first few years of a person's life, with an exorbitant number of brain synapses. Thanks to this event, the individual undergoes progressive transformations and is able to acquire, at this stage of life, various global and fine motor skills, such as mastery of their body, switching between different postures, the ability to move around and handle objects, all of which are fundamental for carrying out activities of daily living and school. In the present study, the patient's progress was compatible with what was expected for his age, since in a short period he was able to acquire several new motor skills, reaching milestones such as rolling over, sitting down and crawling, responding very satisfactorily to the stimuli applied, which, according to the authors Santos, Dantas and Oliveira, can be explained by the significant number of synapses that occur at this stage of life, the phenomenon of neuroplasticity, which lasts from zero to three years, before the first neuronal pruning occurs.

Alves (2021) states in his study that early stimulation is a valuable intervention tool aimed at stimulating the psychomotor development of babies and infants who, for some reason, have developed intrauterine, birth or postpartum disorders, as well as term and syndromic babies with atypical development.

It is characterized by the application of techniques, methods, activities and positions capable of optimizing the acquisition of skills. especially in early childhood. Early stimulation, the intervention technique used as a therapeutic treatment protocol in this study, with the aim of analyzing its applicability in adjusting motor age, proved to be efficient, optimizing the acquisition of fundamental motor skills and abilities for healthy, autonomous and independent child development, corroborating what Alves says in his study.

Early intervention, with the introduction of techniques that emphasize postural control, analysis of alternatives and choice, problem-solving, exploration of the therapeutic environment, manipulation of objects, visomotor stimulation, social interaction and family orientation, provides a range of benefits, contributing to typical motor development, optimizing the achievement of broad and fine motor skills, as well as making a positive contribution in the cognitive, psychological and social spheres of babies at risk (ALMEIDA et al., 2022). The protocol used included kinesiotherapy, manual therapy, expansive and unobstructive respiratory physiotherapy techniques, as well as postural training, decubitus changes, functional and psychomotor exercises, with visual, sound and tactile stimulation, social and environmental interaction, with auxiliary didactic resources, brought together with the aim of providing functionality to the patient and active family adherence to treatment. This is in line with what Almeida et al reported on the application of early stimulation and its positive results in the neuropsychomotor development of newborns, infants and preschoolers, with an improvement in the research participant's global and fine praxis psychomotor engrams.

An experimental study with a non-probabilistic sample of 14 children aged between 7 and 32 months evaluated the effect of early stimulation on the functional performance of children at risk. The sample was submitted to an early intervention program for a period of 10 months, which resulted in a significant increase in the scores of all the domains evaluated, functional skills, self-care, mobility and social function, demonstrating better functional performance of the children after the intervention (RIGONI et al., 2022). Thus, as in the aforementioned study, this research found a substantial improvement in the acquisition and mastery of the patient's motor skills, reflecting greater range of movement, strength and functionality, which will certainly have an impact on better results in school, activities of daily living and leisure, providing a better quality of life for the participant.

Almeida et al (2022) carried out a descriptive ex post facto study with a sample of 7 babies, analyzing how early intervention influences the motor, cognitive and social development of babies at risk. The results indicated an 85% improvement in posture and movement skills, 71% in manipulating objects and 57% in recognizing the function of objects, which corroborates the finding that early stimulation has a positive influence on improving the neuropsychomotor development of babies and children in early childhood. In line with what Almeida et al described, the patient's global praxis improved, with success in the postural domain, transfers of decubitus, movement in space; fine praxis, such as the acquisition and improvement of pressure, pinch and manipulation movements. In addition, although the scope was the acquisition of motor skills, the achievement of motor milestones, interaction with the environment and the researcher, with constant stimulation to expand synapses, underpinned the acquisition of motor milestones, functional kinetic development, with favorable repercussions on cognitive and social functions, achieving the objectives and goals set.

CONCLUSION

It is known that the professional physiotherapist is trained and qualified to assess, and through anamnesis and appropriate propaedeutics, carry out the physiotherapeutic diagnosis, detecting the dysfunctions, outlining objectives and conducts concerned, prescribing and applying the intervention with techniques, methods and resources, based on scientific evidence, in a way that is consistent with the current situation. prophylactic and/or rehabilitative, mitigating the morbidity resulting from congenital heart disease and its corrective surgical procedure.

The results of this study showed that early stimulation, being a transdisciplinary clinical therapeutic intervention, applied during the most significant period of neuroplasticity, proved to be a valuable tool for acquiring skills, adjusting developmental milestones and optimizing healthy motor performance, providing greater independence, autonomy, functionality and consequently having a positive impact on the patient's quality of life. Therefore, both the physiological basis of the technique and its good level of scientific evidence support its successful applicability.

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