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Prevalence of Active Primitive Reflexes and Craniosacral Blocks in Apparently Healthy Children and Relationships with Neurodevelopment Disturbances

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Abstract: Background: In healthy children, the frequency of anomalous persistence of primitive reflexes (PRs) and craniosacral blocks (CBs) are unknown, as well as their impact on neurodevelopment, behaviour disorders and related consequences. We aim to know the prevalence of anomalous PRs and CBs in apparently healthy children and its relationships with behavior and neurodevelopment anomalies. Methods: Participants (n = 120) were evaluated through physical examination to detect PRs and CBs, an ad hoc parent survey to collect perinatal events, and children behavior assessment by teachers using Battelle score. Results: PRs were present in 89.5%. Moro (70.8%), cervical asymmetric (78.3%) and cervical symmetric PRs (67.5%) were the most frequent observed PRs. CBs were found in 83.2%, and the most frequent CBs were dura mater (77.5%) and sphenoid bone (70%) blocks. Moro, cervical asymmetric and cervical symmetric active primitive reflexes are significantly associated to cranial blocks of dura mater, parietal zones, and sphenoid bone sway. Gestational disorders or perinatal complications were associated to a higher frequency of PRs and CBs. The presence of PRs and CBs were associated with abnormal Battelle scores and neurobehavioral problems. Conclusion: Presence of PRs and CBs in children without diagnosed diseases are frequent and related with disturbances in childhood neurodevelopment.

Keywords: primitive reflexes; craniosacral dysfunction; neurodevelopment; early diagnosis; screening

1. Introduction

Primitive reflexes (PR) are automatic, involuntary, and stereotyped movements directed from the brainstem and executed without involvement of the cerebral cortex. On the other hand, craniosacral blocks (CB) are alterations in the movements of the cranial bones and their coordination with the sacrum due to imbalance of membranous tensions and restrictions causing intracranial disorders and distal affectations. PR are indispensable for the survival of the individual in early stages of life. They are necessary to respond in a coordinated manner to sensory stimuli during the period of cortical immaturity until maturation of the central nervous system (CNS) [1]. However, they must be gradually abolished as the subject's development proceeds, allowing for voluntary and functional movement responses. This process of PR abolition is due to the synaptic plasticity of the CNS. Persistent PR can be identified by means of a systematic neurological examination. The persistence of PR in children has been related with neurodevelopment disorders with pathological situations such as attention deficit, hyperactivity, depression, autism and poor concentration, in addition to patterns of alterations in their cognitive, motor, psychological and social development [2–5].

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In addition, the craniosacral system is intimately related to numerous structures, generating bidirectional influences with nervous, musculoskeletal, vascular, lymphatic, endocrine and respiratory systems. In physiological conditions, this system seeks to balance the mobility of membranes and cranial sutures, based on the coordinated movement of the cranial bones and the sacrum blockages in the craniosacral system can be evidenced through craniosacral exploration detecting intracranial membranous tensions [6,7]. Presence of CB has been observed in endocrine disorders due to alteration of the sphenobasilar synchondrosis, visceral disorders due to involvement of the vagus nerve, migraines, delayed motor behavior, stress, anxiety, bruxism and lack of concentration, leading to different disorders that occur as the condition progresses, helping to worsen the physical and mental wellbeing of the child. Currently, after the age of one or one and a half years, the exploration and follow-up of active primitive reflexes (APR) is carried out in children with some diagnosed diseases [5,8]. If neurological homeostasis is disturbed in the child after diagnosing possible CB, this could manifest in the persistence of APR and vice versa.

However, there are no information about persistence of APR and the existence of CB in apparently healthy children. It would be interesting to know this due to APR and CB could affect their daily and future life. The observation of the different behavioral patterns of the child in social and emotional areas, as well as his or her physical and psychological capacities, could help in the early detection of neurodevelopment disturbances. Such detection is essential for the health professional to establish an appropriate preventive treatment to avoid long-term health problems [8–10].

Therefore, our aim is to study the prevalence of APR and CB in apparently healthy children, to analyze potential perinatal causative factors, and to describe the impact on neurodevelopment and educational performance.

2. Materials and Methods

2.1. Study design and participants

A cross-sectional, observational, descriptive study was conducted in a school population. The total study sample included 120 apparently healthy children according to the National Health System without neurological disability. The age of the participants of both sexes ranged from 3 to 8 years. They all belong to attended to the same school.

The application of tests and data collection was carried out within the facilities of the collaborating institution for the study, with the contribution of the entire team and with authorization of the management from the school center and parents or legal representatives of the children.

2.2. Ethics approval

The study was approved by the reference Research Ethics Committee (1763-N-19). This study was registered in *Clinical Trial.gov platform* with study reference NCT05002504.

2.3. Measurements

2.3.1. Primary outcomes

The presence of APR and CB was evaluated through a physical examination by an experienced physiotherapist according to the traditional neurological assessment and the method of Andrzej Pilat [11] and John E. Upledger [12] respectively.

The primitive reflexes explored were Moro reflex, cervical asymmetric, supine labyrinthine tonic, prone labyrinthine tonic, palmar grasp, plantar grasp, lateral trunk propulsion, parachute, Galant, search, cervical symmetric, Babinski, cochleo-palpebral and acoustic. These reflexes were considered as inactive (0) or active (1). On the other hand, the parameters of the craniosacral system explored were dura mater sway, frontal bone, parietal bones, temporal bones, temporomandibular joint and sphenoid bone. These parameters were considered as normal (0) or blockage (1).

2.3.2. Secondary outcomes

The type of pregnancy was classified on a 2-point scale (0 = normal; 1 = with some complication). The time of gestation and type of delivery were each classified on a 3-point scale (0 = 9 months of gestation and natural delivery; 1 = 8 months or instrumental delivery; 2 = 7 months or cesarean delivery). The classification of with/without perinatal problems reflects the sum of the scores (<2 without perinatal problems, ≥2 with perinatal problems).

2.3.3. Tertiary outcomes

Neurobehavioral aspects were analyzed using the "Battelle Developmental Inventory" (BDI), which evaluates five areas of development and performance (personal/social, adaptive, motor, communicative and cognitive) through a structured exam. This information is obtained through an observation guide, both in class and at home, and through information provided by parents and teachers [13]. The neurodevelopmental assessment was carried out taking into account the growth stages standardized by the WHO [14]. The results are assigned in age-adjusted percentages, classified as: low (0–50%), medium (50–80%) and high (80–100%). Thus, "low" values indicate poor overall development in one or more of the areas evaluated; "medium" indicate a normal development according to their age; and finally, "high" indicate an excessive global development in one or more of the evaluated areas. Low and high values are considered impairments in one or more of the evaluated areas [15,16].

2.4. Statistical analysis

Qualitative variables were expressed as frequencies and percentages, and quantitative variables as mean and standard deviation. To check normality of distributions, Kolmogorov-Smirnov tests were performed.

Finally, the chi-square test was used to analyze the differences between age ranges, genders, perinatal and neurobehavioral problems, and teacher assessment versus physical therapy exploration, as well as the association between APR and CB. For all the criteria evaluated, a confidence level of 95% was established, considering a value of $p < 0.05$ as statistically significant.

3. Results

3.1. Prevalence of active primitive reflexes and craniosacral blocks

The overall mean age was 5.49 ± 1.72 years, of which 54 (45%) were girls and 66 (55%) were boys. In 89.5% of the total sample there was evidence of persistence of at least one of the fourteen reflexes studied, and only 10.5% of the children were free of APR. Moro (70.8%), cervical asymmetric (78.3%) and cervical symmetrical (67.5%) reflexes were the most frequent in the child population studied. The cervical asymmetric active reflex follows the natural biological evolution conditioned from infancy to disappear or diminish, although it is still inappropriate to be active from 3 to 8 years. Surprisingly, the Moro and cervical symmetric reflexes are more frequent from 6 to 8 years of age than from 3 to 5 years. There are no significant differences in terms of gender (Table 1).

Table 1. Prevalence of active primitive reflexes by sex and reflex type [a].

Active primitive reflexes	Overall (*n* = 120)	3-5 years (*n* = 60)		6-8 years (*n* = 60)	
		Girls	Boys	Girls	Boys
Moro	70.8	18.4	17	26.5	20.3
Cervical asymmetric	78.3	23.6	26.8	27.9	14.9
Supine labyrinthine	16.7	6.1	3.6	1.5	6.1
Labyrinthine prose	16.7	4.1	5.4	7.4	3.2
Palmar pronation	7.5	1	4.5	0	2
Plantar pronging	18.3	2	6.3	4.4	6.7
Placement	10	2	2.7	1.5	4.1
Parachute	21.7	9.2	5.4	1.5	6.8
Galant	8.3	3.1	3.2	1.5	1.4
Search	2.5	0	0	1.5	1.4
Cervical symmetric	67.5	21.4	18.8	19.1	23.6
Babinski	6.7	7.1	6.3	4.3	8.1
Cocleopalpebral	24.2	1	0	2.9	0.7
Acoustic	3.3	1	0	0	0.7

[a] Prevalence is expressed as percentage, balanced for age group within sex.

In 83.2% of the sample, at least one of the six blocks considered was found and 16.8% of the children did not present CB. The study showed a high prevalence of dura mater, sphenoid bone and parietal zones block in infants referred, but in general, all blocks were more common with increasing age. There are no significant differences in CB appearance between girls and boys (Table 2).

Table 2. Prevalence of craniosacral blocks by sex and block type [a].

Craniosacral Blocks	Overall (*n* = 120)	3-5 years (*n* = 60)		6-8 years (*n* = 60)	
		Girls	Boys	Girls	Boys
Dura mater	77.5	21.5	19.1	22.8	20.2
Frontal bone	10.8	5.9	4.8	6.3	4.9
Parietal zones	30.8	16	9.9	16.8	8.2
Temporaly zones	13.3	9.9	8.9	7.8	8.9
ATM	14.2	16.8	9.8	15.3	9
Sphenoid bone	70	29.9	47.5	31	48.8

[a] Prevalence is expressed as percentage, balanced for age group within sex.

3.2. Relationship between APRs or CBs and Battelle score

A statistically significant increase in Moro, asymmetric, symmetric, plantar pronging, cochlear-palpebral and acoustic reflexes was observed in the low and high score of Battelle scale compared to the normal performance group (Table 3). On the other hand, there was a highly significant effect of dura mater and sphenoid bone blocks on low and high Batelle score ($p < 0.001$) to a lesser extent on parietal bone ($p < 0.05$). Also, sphenoid bone block is more frequent in all boys studied but in case of girls, parietal zones and dura mater are the most recurrent (Table 4).

Table 3. Prevalence of active primitive reflexes by Batelle score (*n* = 120) [a].

Active primitive reflexes	Batelle score			*p*-value
	Low Performance	Normal Performance	High Performance	
Moro	84	30.6	60.9	<0.001
Cervical asymmetric	92	26.4	65.2	<0.001
Cervical symmetrical	80	16.7	91.3	<0.001
Supine labyrinthine	16	16.7	17.4	0.99
Labyrinthine prose	20	18.1	8.7	0.51
Palmar pronation	4	9.7	4.3	0.53
Plantar pronging	20	11.1	39.1	0.01
Placement	8	6.9	21.7	0.11
Parachute	24	20.8	21.7	0.95
Galant	8	6.9	13	0.65
Search	0	2.8	4.3	0.61
Babimski	20	19.4	43.5	0.06
Cocleo-palpebral	0	1.4	13	0.02
Acoustic	52	31.9	82.6	<0.001

[a] Prevalence is expressed as percentage.

Table 4. Prevalence of active craniosacral blocks by Batelle score (*n* = 120) [a].

Craniosacral Blocks	Batelle score			*p*-value
	Low Performance	Normal Performance	High Performance	
Dura mater	80	38.9	87	<0.001
Frontal bone	4	8.3	26.1	0.06
Parietal zones	72	45.8	69.6	0.04
Temporaly zones	4	11.1	30.4	0.12
ATM	16	18.1	0	0.09
Sphenoid bone	84	33.3	95.7	<0.001

3.3. Neurodevelopment outcome in children with perinatal problems

Children who have experienced complications during the prenatal period, during childbirth, or in the first days of birth, show a considerable risk of physical, neuropsychological, cognitive, and behavioral disorders, which are revealed through the Batelle scale ($p < 0.001$) (Table 5).

Table 5. Prevalence of perinatal problems by Batelle score (n = 120) [a].

Perinatal problems	Batelle Score			*p*-value
	Low Performance	Normal Performance	High Performance	
Present	95	7	85	**<0.001**
Absent	5	93	15	**<0.001**

[a] Prevalence is expressed as percentage.

3.4. Association between APRs and CBs

Physical examination of the APR and CB showed statistically significant associations between symmetrical cervical, asymmetrical cervical, and Moro reflexes with dura mater block ($p < 0.001$). These last two are also associated with blockage of the sphenoid bone ($p < 0.001$). Likewise, there is a significant association between the asymmetric cervical reflex with the blockade of the parietal bones ($p < 0.001$). Thus, when there is blockage of the dura mater, it favors the Moro and asymmetric and symmetric cervical reflexes to remain active. As if a blockage of the sphenoid is detected, it causes

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the asymmetric cervical and Moro reflexes to remain inactive. Also, when the parietal bone is blocked, it keeps the cervical asymmetrical reflex active (Table 6).

Table 6. Frequencies and associations between active primitive reflexes and cranial blocks (*n* = 120).

		Dura Mater					Parietal Zones					Sphenoid Bone				
		N		B		*p*	N		B		*p*	N		B		*p*
APR FREQUENT		AF	RF	AF	RF		AF	RF	AF	RF		AF	RF	AF	RF	
Moro	Inactive	21	17.5	14	11.7	<0.001	21	17.5	14	11.7	0.014	6	15	17	13	<0.001
	Active	17	10.8	68	60.0		62	51.7	23	19.2		2	7.3	75	64.7	
Cervical Asymmetric	Inactive	10	8.3	3	2.5	<0.001	9	7.5	39	32.5	<0.001	6	5	10	8.3	<0.001
	Active	18	20.0	89	69.2		18	13.3	54	46.7		35	29.2	69	57.5	
Cervical Symmetric	Inactive	24	20.0	12	10.0	<0.001	29	24.2	10	8.3	0,393	18	15	21	17.5	0.055
	Active	34	28.3	50	41.7		54	45.0	27	22.5		23	19.2	58	48.3	

N, Normal; B, Blocked; AF, Absolute Frequency; RF, Relative Frequency (%).

4. Discussion

Our results show that: i) apparently healthy children can have anomalous activation of certain PR and CB; ii) the presence of these PR is related with presence of CB; iii) the presence of PR and CB could be related with perinatal disorders; iv) presence of PR and CB are related with abnormal neurodevelopmental Batelle scores.

The finding of the existence of APR and CB in older children from 3 to 8 years of age (in whom such RP should be abolished and cranial blocks non-existent, considering normal neurodevelopment), is a remarkable and interesting finding in the present study. Such reflexes showed a statistically significant association with the most frequently found CB. In view of these findings, two questions can be asked: i) Do these PR persist activated from birth, or are they reactivated again or persist for some reason after being abolished? ii) Is the relationship between APR and CB causal or consecutive?

Regarding the first question we can state that the most common alterations in terms of APR (cervical asymmetric -the only reflex more frequent between 3 and 5 years-, Moro and cervical symmetric reflexes) and CB (swaying of the dura mater and sphenoid bone) were positively associated to the age of the child from 6 to 8 years with no sex differences. The asymmetric cervical reflex follows the natural biological evolution conditioned from infancy to disappear or diminish, although it is still inappropriate for it to be active from 3 to 8 years of age. However, the Moro and cervical symmetrical reflexes are more frequent from 6 to 8 years of age than from 3 to 5 years of age. Indeed, it is observed that this group was the one that presented more perinatal and gestational disorders at birth, which could be the reason for remaining active. These data would be of considerable interest to teachers since it would be necessary to try to apply a correction to them in their classrooms. Like this study, Gieysztor *et al*. [17] examined trunk rotation in relation to the persistence of APR in school children 5–9 years, observing trunk rotation problems associated with APR (Galant reflex). In addition, these authors conducted a second study in which they observed the occurrence of APR in healthy children aged 4–6 years and analyzed its impact on psychomotor development. Similarly, Grigg *et al*. [18] examined APR in children from 7 to 12 years old by means of rhythmic therapy and found that cervical asymmetric APR was associated with behavioral problems. Thus, we agree with these authors affirming that after the age of abolition (up to 2 years old), APR persist in children after 3 years old, altering their neurodevelopmental skills even if they are within the group of children classified as normal. However, there are no previous studies that have directly related and demonstrated APR and CB in a population of this size with perinatal variables, type and time of pregnancy, delivery, neurobehavioral factors, and mental concentration in the infant. and its impact on academic performance and various neurodevelopmental factors.

It can be observed that, like the primitive reflexes, the CB follow the natural process of having been blocked during cesarean delivery or instrumental delivery, so neurological affectation can occur

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due to perinatal problems and gestational disorders. So, we detected that in the 3–5 years old group, the cranial bones remain blocked once their fontanels have closed after birth. The sphenoid bone is the most blocked when there have been previous perinatal problems and in those born at 7 or 8 months of gestation. In cesarean deliveries, the greatest cranial involvement was of the dura mater and sphenoid, as this is not the natural exit route for good mobilization of the cranial bones. And in instrumental deliveries, the greatest involvement was of the dura mater because of the undue traction that could be caused by this method. There are no previous studies that have related these variables to reach the results we have observed.

According to the Battelle scale, children with high and low performance considered abnormal are directly associated with the existence of ARP and CB.

To the second question, regarding the relationship of the most common APR with the most frequent CB, we have found an association between the Moro, cervical asymmetric and cervical symmetric reflexes, with sway blocks of the dura mater, sphenoid bone and parietal bone. Such a finding may suggest that dysfunctions in these cranial systems somehow contribute to the persistence of these reflexes. Thus, we would agree in part with H. Haller *et al*. [19] who determined the effectiveness of craniosacral examination and subsequent therapy in individuals with chronic nonspecific cervical problems based on the detection of dura and cranial bone sway blocks. We would also agree with the results of another study by Niklasson *et al*. [20], who compared apparently healthy children (in terms of psycho-behavioral maturation) with children presenting developmental disorders by means of a systematic physiotherapeutic evaluation, demonstrating that despite being children supposedly without pathologies, they could have some underlying developmental disorder, previously undiagnosed.

Perinatal problems such as pregnancies with some degree of difficulty or children born preterm (specifically those born at 7 or 8 months), were associated with the presence of APR and CB, as were instrumental deliveries or cesarean births, which were directly associated to the presence of blockages in the sway of the dura mater and sphenoid bone. Gieysztor *et al*. [21] obtained similar information, observing that preterm infants show a higher level of APR associated to a lower level of psychomotor skills.

On the other hand, there is a significant direct relationship between the neurobehavioral problems of the children (obtained through the parent survey) and the APR and/or CBs If these results are compared with the results of the BDI for neurodevelopment obtained by the teachers, we see that they are along the same lines, and it can be said that the same results are obtained through different assessment methods. Thus, it can be stated that the persistence of the asymmetric and symmetric cervical APR together with the CB of the dura mater, parietal areas and sphenoid bone are coincident in the two relationships. As the most relevant neurobehavioral problem, we obtained results of low or very low concentration abilities (through the parents' survey) that corresponded with low and high BDI values from the teachers' assessment. Therefore, we agree with Alamiri *et al*. [22], who observed abnormal signs of psycho-neurological development in children and their relationship with low cognitive performance, suggesting that such neurobehavioral problems are possibly due to poor neurodevelopmental monitoring during early childhood. In a study by Konicarova & Bob [23] showed the relationship of cervical asymmetric APR with attention deficit hyperactivity disorder (ADHD) in schoolchildren.

Based on the results obtained, we advocate the systematic evaluation of the persistence of active primitive reflexes in children from 3 to 8 years old, as well as of craniosacral tensions and blocks that may contribute to the maintenance of such reflexes. In this way, we will be able to detect early imbalances in these APR and CB, as well as to correct them in time, avoiding major long-term complications that may lead to a possible deficit in children's neurodevelopment. Future research should be focused on the follow-up of children who are detected with any of these disorders and who undergo treatment, in order to check how they evolve. Our research group is currently following up the evolution of the children studied here.

5. Conclusions

After analysing the prevalence of APR and BC in the healthy population, it can be concluded that these situations are highly present in a regular education school. In addition, it can be observed after this study that the presence of APR and BC influences child neurodevelopment in general at a cognitive, social, physical and emotional level.

Consequently, it is recommended to establish systematic physical examination programs, as well as to examine the global development of the child in its psychomotor and intellectual facets.

Author Contributions: G.L.-B. and J.C.-V. designed the study. G.L.-B., I.C.-C. and J.C.-V. performed the children's examinations and data collection. I.C.-C. carried out the statistical analysis. G.L.-B., I.C.-C. and J.C.-V. wrote the manuscript.

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Institutional Review Board Statement: This study was conducted in accordance with the Declaration of Helsinki and approved by the Research Ethics Committee of Córdoba on February 27th, 2020 (1763-N-19). This study was registered in *Clinical Trial.gov platform* with study reference NCT05002504.

Informed Consent Statement: All participants (in these cases, their parents) gave written informed consent before data collection began.

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Conflicts of Interest: The authors declare no conflict of interest.

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