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ORIGINAL ARTICLE

Hand function in the play behavior of children with cerebral palsy

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Abstract

Objective: The aim of this study was to evaluate the influence of hand function on the occupational performance of playing for children with cerebral palsy. *Methods.* Twenty children with cerebral palsy took part in the study, of both genders, aged 3–10 years, with motor abilities ranging from I to V and manual abilities from II to IV. Data were collected using the Assessment of Ludic Behaviour before and after botulinum toxin was applied in the upper limbs to reduce spasticity. *Results:* Significant differences were found between the scores before and after the application of botulinum toxin in relation to the total Assessment of Ludic Behaviour score ($p < 0.001$), as well as in basic ludic interest ($p = 0.003$), basic ludic ability ($p < 0.001$), ludic attitude ($p = 0.008$), and communication of needs and feelings ($p = 0.025$), except for general level of interest ($p = 0.957$). *Conclusions:* The reduction of spasticity permits better handling of the play materials, which promotes the children's involvement in play situations.

Key words: *upper limbs, occupational performance, botulinum toxin, assessment of Ludic Behaviour*

Introduction

Permanent disorders in the development of movement present in children with cerebral palsy (CP) interfere in their use of the hands, limiting the children's ability to maintain independence in daily activities, communication, and social contact (1). Motor deficits in children with CP limit playing because of accessibility barriers regarding toys, difficulties in handling them, interpersonal relations, and environmental conditions (2). These often result in a child having limited experiences in the exploration of both objects and their environment, thus having an impact on play (3).

One obstacle to the functional development of children with CP is the increase of muscular tonus, or spasticity, which makes performing movements difficult, interfering directly in the positioning of the child, hampering eating, hygiene, transfers, and walking, and if left untreated, spasticity can cause disabilities, contractions, deformities, rigidity, dislocations, and pain (4). There are several forms of treatment for spasticity. Botulinum neurotoxin type-A (BoNT-A) has been used in association with other interventions in the management of spasticity in children with CP for almost two decades (5). The action of BoNT-A works by inhibiting excessive involuntary muscular contractions and facilitates the execution of movements, supporting

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the agonist muscle's activity and reducing muscle tone and regulatory circuits of the antagonist muscle (6,7).

In children with CP, the patterns of gripping and adjusting an object in the hands may be insufficient or inadequate to handle toys, which may hinder or limit the play interactions of these children (8). A BoNT-A injection into the upper limb reduces muscle tone without causing significant weakness and improves the range of joint motion and some aspects of functioning, such as the ability to initiate movement in the arm or hand (9,10). The decrease of spasticity could then facilitate handling toy materials and improve the play behavior in children with CP.

Little research has been done on the relationship between children's motor performance abilities and results of children's motor skills (11). Frequently, children with CP are assessed only for their motor skills, but it would be very useful to know whether the improvement in handling play materials, after reduction of spasticity, promotes better play behavior. The aim of this study was to evaluate the influence of hand function on the occupational performance of playing in children with CP, due to spasticity reduction after BoNT-A injection.

Material and methods

This is an applied, non-experimental, cross-sectional, quantitative and descriptive, pre- and post-assessment study, with the purpose of assessing the influence of hand function on the play behavior of children with CP.

Participants

Twenty children with CP, of both genders, 3–10 years old, who were under follow-up at the neurological service of a university hospital in the interior of São Paulo, Brazil took part. The inclusion criteria were: being under the care of this neurological service, receiving BoNT-A (Dysport®) in the upper limbs and understanding simple instructions. All children participated in weekly occupational therapy and physiotherapy sessions.

Instruments

The Assessment of Ludic Behaviour (ALB) was employed (8). It involves five domains: general level of interest, basic ludic interest, basic ludic ability, ludic attitude, and communication of needs and feelings. Through a playful context, this instrument allows the assessor to observe, during play behavior, the ways in which children communicate feelings (phrases, words, gestures, sounds), elements of the play attitude (pleasure, spontaneity, passion for challenge, curiosity, sense of humor, initiative observed occasionally or often), of interest (high interest, medium, or non-expressed interest), and a child's ability to handle a given object (able to handle it alone, with help, or unable). This assessment was cross-culturally adapted for the Brazilian population following the steps of translation, back translation, and evaluation of both idiomatic and conceptual semantic equivalence; afterwards, it was tested with 15 children with CP, showing that this version is valid and reliable (12).

In the children's *general level of interest* domain, 13 aspects related to adult, child, and sensorial environment are observed; the assessor can score 0 (zero) if the child does not demonstrate interest, 1 (one) if the child demonstrates moderate interest, 2 (two) if the child demonstrate strong interest, or NO when this interest has not been observed, with a total possible score of 26. In the *basic ludic interest* and *ability* domains 33 and 38 aspects are observed, respectively, related to actions with regard to objects (pick up, hold or press an object, etc.) and space (change position, maintain a sitting position, etc.), and actions involving the use of objects (pick up a glass, cube, marble; throw or catch a ball; use a pencil, scissors, spoon, etc.) and space (move or carry an object, open or close a door, etc.) and the assessor can score using the same criteria, but is possible to specify how the child accomplished the actions, which hand is used, what is his/her difficulty, among other examples, with the possibility of obtaining a total score of 66 and 76, respectively. In *ludic attitude*, six aspects are observed that involve curiosity, initiative, sense of humor, pleasure, enjoyment of challenges, and spontaneity; the assessor can score 0 if the child does not demonstrate ludic attitude, 1 if the child demonstrates sporadic ludic attitude, 2 if the child demonstrates strong ludic attitude and the total possible score is 12. In the *communication of needs and feelings*, eight aspects are observed that involve needs – physiological, attention, and security; and feelings – dis/pleasure, sadness, anger and fear; the assessor can score 0 if the child does not demonstrate a reaction, 1 if the child demonstrate his/her needs and feelings using facial expressions; 2 if the child expresses his/her needs and feelings by gestures; 3 if the child expresses his/her needs and feelings by crying or making sounds; and 4 if the child expresses his/her needs and feelings using words or sentences. The total score possible is 32.

Materials

The protocol of application for this assessment does not suggest specific materials; it is necessary not only just to observe the child playing with different toys and objects, but in this present research also to obtain reliable data concerning the play of children. The toys and objects used during the assessment were the same in pre- and post-BoNT-A application and included: hammer and pegs bench, Lego® blocks, miniature cars, teddy bears, scissors, pencils, paper, plastic cup with a screw-on lid, marbles, a plastic spoon, and a miniature kitchen set. These materials were the same for all participants. These materials were chosen to involve the age range of children participating in the research (3–10 years old) and included to facilitate the evaluation of items inside the ALB, such as to grip, to heap, to empty, to hit, to cut, to draw, to release something, tactile and motor exploration, and pretend play.

Data collection

This study was made in 2009 and 2010. The participants were assessed in a private room in the ambulatory neurology infant's section of the university hospital in a city in the state of Sao Paulo (Brazil).

Two assessments using the ALB took place with each child (AV1 and AV2). The assessment before the application of botulinum toxin in the upper limbs was named AV1 and, two months after the application, the children's play behavior was assessed once again; this was named AV2. The defined time of two months between each evaluation (pre- and post-BoNT-A application) was based on the average time of botulinum toxin efficacy, which has a present average duration of three months (13).

In both evaluations (AV1 and AV2) using the ALB, toys were offered to children within a play context established during both data-collection sessions, which made it possible to assess the children's *general level of interest*, their basic skills and the characteristics of their attitudes.

Both assessments were carried out in a private environment with reduced physical and auditory distractions to facilitate the implementation of the ALB. Each child was assessed individually, and the parents were invited to stay with the child, but were informed that facilitating the child's play was not allowed. The assessment procedure was filmed and the camera was positioned two meters away from the child in order to register the whole assessment. Filming also allowed the observation of play, as well as the evaluation of inter-examiner reliability.

Child participants were classified by means of the Gross Motor Function Classification System, Expanded & Revised (GMFCS E & R) (14) in their initial contact only, in order to identify their motor levels and complement the topographic classification of cerebral palsy. The parents were interviewed as to how their children use their hands when handling objects in daily activities, which allowed the classification of all the children using the Manual Ability Classification System (MACS) (15).

Data analysis

Because the Brazilian version of the ALB is a new instrument, a reliability analysis was performed. Internal consistency was assessed using Cronbach's alpha coefficient of agreement (16). Inter-rater reliability was measured using the weighted Kappa (17), comparing the ratings of two raters. Measurements of only one of the raters, who had more experience in ALB assessment, were used for the remainder of the analysis. Data relate to a small sample, with no evidence of the scores adhering to a normal distribution, which led to the use of non-parametrical analysis. Thus, to assess whether there was a significant difference between the average ALB scores before and after BoNT-A, the Wilcoxon Signed Ranks test was used. The level of significance was set at 0.05 for all statistical tests. The correlation between the number of BoNT-A applications and the total score on the ALB was analyzed using the Spearman correlation test and the influence of median of BoNT-A application and the score on the ALB was analyzed using the Mann–Whitney test.

Ethical considerations

This study was approved by the Research Ethics Committee at University of São Paulo at Ribeirão Preto Medical School. The participants' parents or guardians were informed about the study and provided written consent.

Results

The participant characteristics show that the sample is heterogeneous. Among the 20 children assessed, 11 were female (55%) and nine were male (45%), with a mean age of 6.6 years. As for the anatomical distribution, 13 children had bilateral CP and seven presented with unilateral CP. In relation to the motor level, according to the GMFCS, six children (30%) were level I, one child (5%) was level II, one (5%) level III, seven children (35%) level IV, and five children (25%) level V. In relation to MACS, six children were classified level II (CP unilateral), six children level III (CP bilateral), and six children level IV (CP bilateral), as shown in Table I. Two children were less than four years old, and therefore were not classified by MACS, but one of them (P10) was wheelchair dependent (did not push alone) and partially handled one limited variable of objects when put in her hand, such as Lego® blocks and sticks, remaining seated with the support

Table I. Comparison of children's total scores of ALB before and after BoNT-A application, at each motor level and dosage and muscle that received BoNT-A.

Participant	Age/year	gender	BoNT-Aapplication	GMFCS	MACS	Diagnosis of CP	Dosage and muscles	Total score ABL Before BoNT-A	Total score ABL after BoNT-A
P4	9	M	4th	I	II	Unilateral	PL (1.73 U/Kg); EC (1.73 U/Kg); FDS (2.6 U/Kg); OP (1.15 U/Kg) ***	128	140
P11	3	M	1th	I	-	Unilateral	BRA** (4.54 U/Kg); PT** (5.84 U/Kg)	136	142
P12	7	F	1th	I	II	Unilateral	BR (3.24 U/Kg); BRA (3.24 U/Kg); PT (3.24 U/Kg)***	128	139
P18	5	F	1th	I	II	Unilateral	BRA (4 U/Kg); OP (2.66 U/Kg)**	119	140
P19	5	M	6th	I	II	Unilateral	PT (3.5 U/Kg); FC (3.5 U/Kg)**	134	143
P20	7	M	1th	I	II	Unilateral	PT (5 U/Kg); BRA (6 U/Kg)**	128	145
P9	6	F	7th	II	/II	Unilateral	OP** (0.67 U/Kg); PT** (3.05 U/Kg)	133	144
P6	9	M	9th	III	III	Bilateral	BR** (2.85 U/Kg); BRA*** (2.85 U/Kg); PT*** (4.28 U/Kg)	185	203
P16	5	F	1th	III	III	Bilateral	BRA (2.22 U/Kg); BR (2.22 U/Kg); PT (3.70 U/Kg)***	132	134
P5	8	F	2th	IV	III	Bilateral	OP (1.81 U/Kg); BRA (4.09 U/Kg); BR (4.09 U/Kg); PT (5.45 U/Kg) **	101	114
P7	9	M	6th	IV	III	Bilateral	FC (2 U/Kg); BR (2 U/Kg); PT (3 U/Kg)*	125	123
P8	7	M	1th	IV	IV	Bilateral	FC*** (6.86 U/kg)	94	111
P10	3	F	4th	IV	-	Bilateral	OP*** (2.22 U/Kg)	88	120
P13	5	F	3th	IV	IV	Bilateral	BRA** (4 U/Kg); BR** (4 U/Kg); PT** (5.33 U/Kg)	108	119
P14	7	F	6th	IV	IV	Bilateral	BRA* (2.96 U/Kg); BR* (2.96 U/Kg); PT* (3.33 U/Kg); FC** (2.96 U/Kg); OP** (0.74 U/Kg)	174	186
P1	9	F	1th	V	IV	Bilateral	BRA (1.76 U/Kg); FC (1.76 U/Kg); PT (2.64 U/Kg)*	142	148
P2	9	M	6th	V	III	Bilateral	BRA*** (2.14 U/Kg); BR*** (2.14 U/Kg); FC*** (2.14 U/Kg); PT*** (3.21 U/Kg)	71	74

Table I. (*Continued*).

Participant	Age/year	gender	BoNT-Aapplication	GMFCS	MACS	Diagnosis of CP	Dosage and muscles	Total score ABL Before BoNT-A	Total score ABL after BoNT-A
P3	9	F	8th	V	IV	Bilateral	RF*(6.81 U/Kg); BR* (2.72 U/Kg); FC** (2.72 U/Kg); FDS** (2.72 U/Kg)	101	126
P15	6	M	1th	V	III	Bilateral	BR*** (2.6 U/Kg)	119	133
P17	5	F	5th	V	IV	Bilateral	BRA*** (4.8 U/Kg); FC*** (4.8 U/Kg); OP*** (1.56 U/Kg)	76	75

Notes: Muscles abbreviations: BRA = brachialis; FC = flexor carpi; PT = pronador teres; BR = brachioradialis; FDS = flexor digitorum superficiales; OP = opponens pollicis; EC = extensor carpi; PL = palmaris longus. Body side of BoNT-A application: * = bilateral; ** = left; *** = right.

of others or in an adapted chair; the other participant (P11) handled objects easily, except those that require precision and speed, but had maintained his left upper limb with elbow flexion tendency. As for the intervention provided during this study, all these children received BoNT-A at least in the upper limbs.

As regards the reliability of the ALB, specifically in relation to internal consistency, a value of 0.83 was found before the application and after the application the value was 0.84. In relation to inter-rater reliability, the weighted Kappa coefficient of agreement was used and the results are shown in Table II.

Table III shows the statistical summary of means, the standard deviations of the means, and 95% confidence intervals, both before and after BoNT-A applications, as well as a comparison of the children's mean scores in all areas of the ALB before and after BoNT-A applications, using the Wilcoxon test.

Regarding the children's *general level of interest*, there was no significant difference between the average scores before and after BoNT-A applications with i = 0.957. There was significant improvement in the field *basic ludic interest* after reduction of spasticity ($p = 0.003$), with 70% of the children scoring higher on the second assessment; 25% of the children maintained the same score, and only one participant had a lower score on the second assessment, which might have been influenced by the fact that the child was sick that day.

Regarding *basic ludic ability*, 90% of the children had higher scores on the second assessment, which indicates that the reduction of spasticity has significant influence in this area ($p < 0.001$). Only 10% of the children maintained the same score on the first and second assessments. For *ludic attitude*, 35% of the children had higher scores on the second assessment. The remaining 65% maintained the same scores. There was a significant difference in ludic attitude ($p = 0.008$) before and after BoNT-A applications.

In the assessment of *communication of needs and feelings*, the same score for the first and second assessments was observed in 75% of the children; 25% of the children, however, obtained lower scores on the second evaluation. A high score can be obtained in this domain if the child uses negative expressions, such as grimaces, screams, or crying, to demonstrate fear or to show dislike of some unfamiliar person or place. A significant difference was observed (p = 0.025), being influenced by the context before the BoNT-A application.

Table II. Inter-examiner reliability: Percentage agreement and Kappa coefficients.

	Before application			After application		
Item	% agreement	Kappa	p	% agreement	Kappa	p
General level of Interest	99.6	0.948	< 0.001	100.0	1.000	< 0.001
Basic ludic interest	99.7	0.985	< 0.001	99.8	0.990	< 0.001
Basic ludic abilities	99.7	0.983	< 0.001	99.7	0.983	< 0.001
Ludic attitude	100.0	1.000	< 0.001	100.0	1.000	< 0.001
Communication of needs and feelings	100.0	1.000	< 0.001	100.0	1.000	< 0.001

Table III. Comparison of mean scores of children in all domains of the ALB before and after BoNT-A application.

Item	Before application				After application					
	Mean	SD	95% confidence interval		Mean	SD	95% confidence interval		Wilcoxon test (p)	Conclusion
General level of Interest	11.8	0.29	11.2	12.4	11.7	0.16	11.4	12.1	0.957	Scores After = Before
Basic ludic interest	55.8	3.61	48.2	63.4	59.3	3.28	52.5	66.2	0.003	Scores After > Before
Basic ludic abilities	38.6	2.56	33.2	43.9	47.3	3.28	40.4	54.2	< 0.001	Scores After > Before
Ludic attitude	6.7	0.49	5.6	7.7	7.1	0.46	6.1	8.0	0.008	Scores After > Before
Communication of needs and feelings	8.4	0.75	6.8	10.0	7.4	0.51	6.3	8.5	0.025	Scores After < Before
Total score ALB	121.1	6.38	107.73	134.46	132.9	6.63	119.06	146.83	< 0.001	Scores After > Before

All children received BoNT-A applications in the upper limb muscles (inclusion criterion). The muscles in which the children received botulinum toxin were more frequently pronator teres (65% of children), brachialis (60% of children), and brachioradialis (50% of children). This study did not statistically analyze the relationship between muscles that received BoNT-A and ALB total scores because the sample was heterogeneous and not big enough, and because the aim was to analyze the hand function of children during the play action.

By adding up all domain scores, it is possible to obtain the total ALB score. When comparing the total score before and after BoNT-A of each participant, 90% of them presented play improvement in the second assessment, independently of which muscles BoNT-A was applied to and their respective dosages, as can be seen in Table I.

Table IV. Comparison of scores of children in all domains of the Assessment of Ludic Behaviour (ABL) before and after application of botulinum toxin through Wilcoxon Signed Ranks test, at each level of MACS.

MACS	Item	Average scores		Wilcoxon Test (p)	Conclusion
		Before	After		
II	General level of interest	12.0	12.0	n.a.	-
	Basic ludic interest	58.3	61.5	0.05	Scores After = Before
	Basic ludic ability	40.8	51.0	0.03	Scores After > Before
	Ludic attitude	9.2	9.3	0.32	Scores After = Before
	Communication of needs and feelings	8.0	8.0	n.a.	-
	All items	25.7	28.4	< 0.01	Scores After > Before
III	General level of interest	11.3	11.3	1.00	Scores After = Before
	Basic ludic interest	54.54	55.3	0.49	Scores After = Before
	Basic ludic ability	40.2	47.7	0.07	Scores After = Before
	Ludic attitude	6.5	6.8	0.15	Scores After = Before
	Communication of needs and feelings	10.0	8.7	0.16	Scores After = Before
	All items	24.5	26.0	0.20	Scores After = Before
IV	General level of interest	12.0	11.8	0.89	Scores After = Before
	Basic ludic interest	58.2	61.8	0.07	Scores After = Before
	Basic ludic ability	34.5	43.4	0.03	Scores After > Before
	Ludic attitude	4.5	5.2	0.08	Scores After = Before
	Communication of needs and feelings	6.7	5.3	0.16	Scores After = Before
	All items	23.2	25.5	0.02	Scores After > Before

Note: n.a.: test is not applicable – all the scores are equal.

Significant differences were found in the statistical analysis of all ALB items between the initial and the final assessment with $p < 0.001$, which indicates the influence of hand function on the play activity with spasticity reduction after BoNT-A application, and, consequently, on the play behavior of the children with different levels of motor impairment due to cerebral palsy, as observed in Table III.

Significant differences were found in the statistical analysis of the instrument between the initial and the final assessment of children classified with MACS level II and IV, but this significance was not found in children with MACS level III, as can be seen in Table IV.

The number of BoNT-A applications varied between 1 and 9 with a median of 3 applications. The Spearman correlation between the number of BoNT-A applications and scores on the first assessments ($p = 0.88$), as well as the correlation between the number of applications and the score differences ($p = 0.98$), were very low and not significant. Further, the children were placed in two groups, below and above the median number of BoNT-A application, then the Mann–Whitney test compared the scores on the first assessment in each group, with results not significant ($p = 0.91$). The same was true when comparing the score differences in each group below and above the median number of BoNT-A applications ($p = 0.82$).

Most children showed better play behavior after the BoNT-A. While some could only manipulate objects to explore their properties, others could improve the use of the play materials functionally and yet others could improve the use of the play materials in pretend scenarios, as observed in Table V.

Data analysis and discussion

This study analyzed each participant individually, according to the five dimensions proposed by the ALB, and compared the influence of hand function in play behavior of children with CP, due to spasticity reduction after botulinum toxin application.

In relation to reliability analysis, the results related to internal consistency before and after the BoNT-A application indicated a very good level of consistency, according to the criteria suggested by Nunnally and Bernstein (18). The inter-rater reliability results assure an almost perfect agreement, according to the criteria of Landis and Koch (19), in both rounds. This information guarantees the reliability of this study.

The analysis of the score before and after BoNT-A application reveals that the reduction of spasticity did not influence the hand function related to *general level of interest*. This dimension of the ALB assesses the interest of the child in adults and other children in relation to the presence, actions, and communication (verbal and non-verbal) of the children and their interest in sensorial environments, such as visual, tactile, vestibular, auditory, and olfactory elements (12). This domain is more related to social participation and interaction with peers that involves cognitive skills (3) than with motor action. Thus, this could explain the limited influence of spasticity reduction.

Basic ludic interest and *ability* assess the child's actions in relation to objects (press/release movement; pick up, hold, hit, and release object) and space (change position, maintain a sitting position, move about and visually explore a new place) and how the child uses objects and space (pick up a glass, marble, cube; screw/unscrew; throw/catch balloon, ball; pile; empty/fill; use a pencil, scissors, spoon; imagine in play situation; express feeling; combine objects to play, etc.) (12). In the present study, both domains showed improvement in the hand function by reducing spasticity, with a significant difference.

Almost all child participants in this study showed a better score in *basic ludic ability* with the reduction of spasticity after BoNT-A application, in agreement with the results obtained in several other studies that identified a significant increase in the fundamental functional aspects of the hand (gripping and coordination) after the application of type A botulinum toxin in children with CP (20–23).

The upper limb muscle function in the children who received botulinum toxin more frequently displays quick flexion and extension of elbow (brachialis); flexion of elbow, pronation of forearm, and supination until neutral point (brachioradialis); and pronation and supination of forearm (pronator teres) (24). The actions of these muscles are responsible for gripping, holding, and handling. The decrease in the spasticity of these muscles, then, could contribute to improve the manipulation of objects. The study by Kennedy et al. (11) indicates a significant correlation of children's motor skill performance with fine manual control and manual coordination.

The assessment of the *basic ludic interest* may indicate whether the child comprehends the principle of the activity (cognitive aspect), even though he or she may not be able to perform the activity (motor aspect) (8). Overall, during the second assessment, the children showed more interest in using their handicapped limbs, where the botulinum toxin had been applied, requiring fewer stimuli to use them during the games. The present results suggest that, when the child has greater capacity to handle the play materials, she/he also has more interest in play. This could be explained by Pfeifer et al. (3), who found in their research that not all children with CP have difficulty in skills to develop their play, initiate play ideas, and develop stories using the toys in play scenes.

Table V. Types of play behaviors noted after the reduction of spasticity by BoNT-A for each participant.

	Performance
P1	Performed actions with less difficulty, and with less help from the researcher, was able to handle objects more easily during play, performing better on the screwing and unscrewing movement
P2	Maintained difficulties in performing actions, needing help from the researcher and sometimes refusing to use the affected hand. Maintained object handling characteristics during play, without significant performance changes
P3	Made movements with the upper left limb more effectively and with the upper right limb with less difficulty. Demonstrated greater engagement in the active exploration of the toys, as well as in the discovery of their functions. Was able to handle objects more easily during play, needing less help from the researcher
P4	Was able to seize, release, and hold objects (cube, ball, spoon) more effectively and with less help from the researcher
P5	Was able to hold, release, squeeze, and seize objects (pencil, scissors, ball, cup, and spoon) with less difficulty and with less help from the researcher. In the reassessment, used pretend to imagine situations and express feelings
P6	Presented better performance in upper left limb, was able to seize a cube, a ball, use a pencil, and make screwing and unscrewing movements. Was able to effectively make screwing and unscrewing movements with the upper right limb, cast and throw a ball, use scissors, and imitate weaving movement
P7	Needed help from the researcher during both assessments but, during the reassessment, performed better to hammer and seize a cup
P8	Was able to handle some objects (pencil and spoon) more easily during play, demonstrating greater interest and dedication in actions
P9	Performed better on seizing, releasing, squeezing and holding a ball, stacking Lego® blocks, imitating weaving movement, emptying and filling a cup with balls, using a spoon
P10	Was able to handle objects more easily and effectively during play, with less help from the researcher. Demonstrated greater involvement in the active exploration of toys, as well as in the discovery of their functions
P11	Performed better on seizing and holding objects (ball) during play, demonstrating greater involvement and needing less help from the researcher
P12	Performed better and was able to seize a ball, a cube, stack Lego® blocks, and imitate weaving movement more effectively
P13	Was able to handle objects more easily and effectively during play, such as seizing a cube, a ball, hammering, making screwing and unscrewing movements, imitating weaving movement, using a pencil, and handling a spoon
P14	Performed better, mainly in the upper left limb, and was able to perform actions more effectively and without the researcher's help. Was able to handle objects more easily during play, such as seizing a cube, a ball, emptying and filling a cup, making screwing and unscrewing movements, imitating weaving movement, and using a spoon
P15	Performed better on all actions assessed and was able to perform them more effectively and without the help of the researcher. Was able to handle objects more easily during play, such as seizing a cube, a cup, a ball, emptying and filling a cup, making screwing and unscrewing movements, stacking Lego® blocks, emptying and filling a cup, and using a spoon
P16	Was able to perform some actions more easily and without the help of the researcher, such as squeezing and releasing an object, demonstrating greater confidence in the use of the right upper limb
P17	Experienced difficulty in making movements, needing help from the researcher during both evaluations. During the reassessment, the child was ill
P18	Was able to handle objects more easily and effectively during play, such as tightening and releasing, seizing and holding an object (a cube, a ball, a cup, a spoon), hammering, making screwing and unscrewing movements, using scissors, with less help from the researcher and using the left upper limb more effectively
P19	Was able to handle objects more easily and effectively during play, such as tightening and releasing, seizing and holding an object (a cube, a ball, a cup), stacking Lego® blocks, imitating weaving movement, making screwing and unscrewing movements, using scissors and a pencil, with less help from the researcher and more frequently using the left upper limb
P20	Performed better on actions that involved seizing, squeezing, knocking, and releasing objects during play, demonstrating greater ease and efficacy to hold a cup, a cube, stacking and handling Lego® blocks, making screwing and unscrewing movements, and using a pencil and a spoon

The *ludic attitude* assesses the child's characteristics of curiosity, initiative, sense of humor, pleasure, enjoyment of challenge, and spontaneity (8,12). In this study, *ludic attitude* has increased in some children and the results were significant. During play, children express emotions, motivation, self-control, curiosity, pleasure, and skill, providing clues to their social partners, letting their imagination emerge and using their sense of humor (25,26). These results suggest that decrease in spasticity promotes the handling of toys, and that this increases the child's *ludic attitude*.

The *communication of needs and feelings domain* assesses the needs (physiological, attention, and security) and feelings (pleasure, displeasure, sadness, anger, and fear) of children during play (8,12). The results of this study show a significant difference, with higher scores for AV1 compared with AV2; these results may be due to the fact that the children were afraid of the unknown situation of receiving a BoNT-A injection; crying in the first assessment, which was not observed during the second assessment, thus could explain the lower score.

Overall, the assessed children expressed themselves verbally with words and phrases. Even the children with more serious motor impairment were capable of using verbal communication to express themselves during the assessment before the BoNT-A application and no alterations were observed in the way the children expressed themselves, which means that this aspect was not influenced by hand function after spasticity reduction.

The hand function influenced the significant difference found between MACS levels II and IV: on the one hand, the ALB scores before and after BoNT-A application; on the other, in the assessment of basic ludic ability. These results could be explained by the fact that the botulinum toxin applied in the upper limbs improves the function and the handling of objects (6), as well as the positioning and transferring of objects, enabling children to acquire new hand abilities (27). The limited time range of this study, however, does not permit an understanding of why this does not occur with MACS level III.

This study used a cross-sectional method, assessing children at two different points of time and compared each child with him/herself; it did not use control groups and did not analyze the other therapies that were occurring together with the BoNT-A. Although all children were receiving weekly therapy intervention, the therapy method and the frequencies (once, twice, or three times a week) were not analyzed, which could provide other information that contributes or not to the improvement of each child.

Motor limitation may decrease opportunities to play and, therefore, children with CP with greater motor limitations had diminished play ability (3). The present study found improvement in children's play behavior (see Table I, total ALB scores) after spasticity reduction by BoNT-A application. The improvement in the play behavior scores was found across the sample, except for two children, suggesting that, when the involvement of children with CP in play situations is facilitated (in this case, handling play materials better, because the spasticity was decreased), their occupational performance of play could improve, which is vital for the children's growth and development of motor, cognitive, and social skills.

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