ORIGINAL ARTICLE

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Cerebral palsy - upper limbs: rehabilitation

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DESCRIPTION OF THE EVIDENCE COLLECTION METHOD

This study revised articles from the MEDLINE (PubMed) databases and other research sources, with no time limit. To do so, the search strategy adopted was based on (P.I.C.O.) structured questions (from the initials "Patient"; "Intervention"; "Control" and "Outcome". As keywords were used:

Question 1: (Cerebral Palsy OR Cerebral palsy spastic diplegic OR hemiplegia OR quadriplegia) AND (patient positioning OR posture OR self-help devices);

Question 2: (Cerebral Palsy OR Cerebral palsy spastic diplegic OR hemiplegia OR quadriplegia) AND (patient positioning OR posture);

Question 3: (Cerebral Palsy) AND (Activities of Daily Living/education OR Interior Design and Furnishings OR Patient Positioning);

Question 4: (Rehabilitation treatment OR motor activity) AND cerebral palsy AND home care;

Question 5: Cerebral Palsy AND (Somatosensory Disorders OR sensation Disorders OR Psycomotor Performance OR Sensation OR Perception);

Question 6: Cerebral Palsy AND (Upper Extremity OR Upper Limb) AND (Restraint, Physical OR Constraint Induced Therapy OR Physical Therapy Modalities);

Question 7: Cerebral Palsy AND (kinesio tape OR KT OR bandages OR surgical tape OR Therapeutic taping OR Athletic Tape) AND (rehabilitation OR physical therapy techniques);

Question 8: (Cerebral Palsy OR Upper Extremity) AND (Orthotic Devices OR Splints OR Neoprene OR Orthopedic Equipment);

Question 9: (Cerebral Palsy OR Upper Extremity) AND (Botulinum Toxins OR Orthopedic Equipment OR Orthotic Devices);

Question 10: Cerebral Palsy AND (Upper Extremity OR Upper Limb) AND (Botulinum Toxins, Type A OR Botox).

With the above keywords crossings were performed according to the proposed theme in each topic of the (P.I.C.O.) questions. After analyzing this material, therapy narrow articles regarding the questions were selected and, by studying those, the evidences that fundamented the directives of this document were established.

LEVEL OF RECOMMENDATION AND EVIDENCE:

A: Strong consistency experimental or observational studies.

B: Fair consistency experimental or observational studies.

C: Case reports (uncontrolled studies).

D: Opinion lacking critical evaluation, based on consensus, physiological studies or animal models.

OBJECTIVES:

Offering information regarding the effectiveness of available auxiliary resources for the treatment of children with Cerebral Palsy.

PROCEDURES:

Analyzing the main resources that help in the process of promotion and rehabilitation of functional skills.

CONFLICTS OF INTERESTS:

There are no declared conflicts of interests.

INTRODUCTION

Cerebral Palsy (CP) describes a group of disorders in movement and posture development, resulting in limitation on activities. Those are attributed to non-progressive disorders that occur in the developing brain. CP motor disorders are, in general, accompanied by sensation, perception, cognition, communication and behavior alterations, and may be accompanied by convulsive crises[1] **(D)**.

Motor disorders are the main secondary alterations of cerebral lesion. These motor disorders may result in postural, movement, balance and gait alterations. Motor development in general is impaired from the functional point of view[1] **(D)**.

It is estimated that in underdeveloped countries the prevalence is higher than in developed countries, being observed indices of 7:1000 borne alive. In Brazil, the estimated CP data are of 30.000 to 40.000 new cases per year[2] **(C)**.

CP diagnose is, basically, clinic and a rigorous evaluation is indispensable for better follow-up, maintenance and treatment of the diseased child.

In the literature there are a few motor function classification scales for CP children, such as the GMFCS (Gross Motor Function

Classification System), supplied by the CanChild Centre of Canada. This is the study center responsible for specifying the scale for evaluation of the CP child, being that this scale assesses the child's functional mobility in five increasing gravity levels, based in the voluntarily initiated movement, and with particular emphasis in sitting and walking:

- Level I: optimal trunk control and independent gait;
- Level II: good trunk control and gait limitations;
- Level III: good trunk control and gait dependent on locomotion auxiliary devices;
- Level IV: poor trunk control and gait dependent of auxiliary devices and supervision with possible use of powered wheelchair;
- Level V: limited trunk control and locomotion with wheelchair.

This scale is used in the assessment of individuals aged up to eighteen years, being that in premature children the corrected age should be considered. The classification is ordinal, with no intention that the distances between levels are considered equal, or that CP children be distributed, equally, within the five levels[3] **(B)**.

The physical rehabilitation program for CP children must count with the intervention of a multidisciplinary team, each one of the different professionals contributes with their expertise to minimize the difficulties presented by their patients, making them improve their performance in their activities of daily life (ADL) and activities of practical life (APL), thus overcoming their limitations and acquiring greater autonomy. We cannot think of rehabilitation methods without binding the available interventions for the CP child and perfecting their treatment. However, in rehabilitation, specially in the fields of Physical Therapy and Occupational Therapy, questions arise along the course of clinical practice, that direct the search for evidence-based practice.

1. Does the positioning sitting on a chair interfere in upper limb function of children with cerebral palsy?

Children with cerebral palsy, due to their mobility impairment, caused by abnormal movement, tone alterations and difficulty in movement coordination, may have their upper limb motor development reduced. A sitting posture in an inadequate manner may accentuate the motor dysfunction.

Children with CP, of the type spastic and athetoid, aged between eight to sixteen years, were randomized and placed on an equipment in which the seat would recline 30°, 15°, and 0°, posterior, and 15°, anterior. Sitting on this equipment the children went from shoulder abdution to shoulder adduction, aiming to activate a device in front of them for ten times, with a five-minute interval, on the four angles. This procedure was repeated one more time in the other direction.

Spastic children showed better time with 0° and athetoid children with 15° of anterior inclination[4] **(B)**.

The benefit of such equipment is being extensively documented in the literature: improvement in postural control and reduction in pathological movements was reached with anterior seat inclination and, therefore, as an increase in cervical control and arms functionality, when associated with the use of abduction orthosis and cut-out table, in posterior inclination opposition[5] **(B)**.

Recommendation

The use of different angles is recommended when the child is sitting, to promote better development of upper limbs, taking into consideration tone alteration. Spastic children showed better time with 0° and athetoid children with 15° of anterior inclination[4] **(B)**.

Anterior inclination presents greater scientific support regarding positively affecting children's function, however, due to the high variability of results and diversity within CP children, an individual and accurate evaluation taking into consideration functionality is recommended[5] **(B)**.

2. Does the trunk position interfere in upper limb function of children with CP?

A group with twelve children aged between five and twelve years, diagnosed with CP, presenting hemiparesia, diparesia or tetraparesia, capable of sitting up without support and who comprehended instructions, were randomized in two groups, the first would perform the task with restrained trunk, and the other would not.

The evaluation would be done five times: three times before training, immediately, after and three months after training.

The training consisted of one hour of activity, three times a weel for five weeks.

It was observed a better performance of the arm, greater extension of the elbow and reduction in compensatory movements of the trunk in the group that had the trunk restrained, being that those effects persisted in this group on the final evaluation[6] **(B)**.

Recommendation

It is recommended the association of the training of one activity for one hour, three times a week, during at least five weeks, to the trunk constraint, aiming to improve movements of upper limbs and reduce trunk compensatory movements[6] **(B)**.

3. What is the best school furniture to favour the positioning of children with cerebral palsy at school?

The effectiveness for a better caligraphy skill may be related to ergonomic factors. During writing are required postural control, and upper limb stabilization and mobilization. Ergonomy involves the interaction and adaptation between human skills and work demands. Frequently, children with Cerebral Palsy with no trunk control and variation and fluctuation in muscle tone present difficulty in the fine motor coordination of writing.

We analyzed the motor performance and hand dexterity in writing in four types of tables:

- Table - 1: Regular table
- Table - 2: Inclined regular table
- Table - 3: Cut-out table
- Table - 4: Inclined cut-out table

During the study the patients were positioned sitting on chairs with 90° hip and spine angle.

In a study of students with Cerebral Palsy, aged five to twenty years, being nine with spastic diplegia and twenty-three with athetoid quadriplegia, the standard test of *Motor Accuracy Test*, MAC, was applied to measure eye-hand control, motor planning, and movement precision. MAC analyzes the components involved and required in the caligraphy skill. Results indicate that the cut-out table is significantly better for fine motor skill than the regular table. More benefit is observed for students with Cerebral Palsy of the type athetoid quadriplegia than for spastic diplegia, since the cut-out table provides more support for trunk and upper limb during writing[7] **(B).**

In a group of twenty-six children with Cerebral Palsy with left hemiplegia aged between eight and twelve years, the *Minnesota*

Handwriting, MHA, test was applied, to evaluate caligraphy quality related to speed, legibility and spacing, alignment, size, and shape. The results show better performance in the parameters of caligraphy speed and size during the use of cut-out table compared to the other types of table. Better scores were verified in the parameters of caligraphy spacing, legibility, and alignment when using cut-out table with 20° inclination compared with the other tables[8] **(B).**

Posture was identified as a significant factor that incluences the performance during activities. It considers that the use of 10° inclination when reading and writing seems to have a positive effect in posture, being more appropriate for a better vision and less flexion of the neck[7,8] **(B)**.

Participated in the study children (n = 20), being children with no motor difficulties (n = 10) and children with CP (n = 10) aged four to fifteen years. A chair was designed and produced that permits variation of the seat angle. This chair allows adjustments in the back, seat height, and foot support. To evaluate motor performance function of upper limb it was selected by the authors a list of tasks to be performed by the patients, and they evaluated performance with analysis of the time spent for execution. There is no description of the type of table used for the evaluation of the types of chairs. Patients executed the tasks positioned in three types of chairs: Chair 1: no inclination 0°, chair 2: tilt 5° posterior inclination of seat, and chair 3: tilt 5° anterior inclination or seat. Results suggest that the anterior inclination of the seat may difficult postural stability, with no improvement in upper limb functional performance[9] **(B)**.

It is verified that there is not a standard for the sitting position of children with CP in school phase. It is considered that a certain conjunction of factors will produce a favourable body structure alignment for better function in the activities. To do so, we must act in an individualized manner with each child: (a) ensure that the equipment promotes functional weight support, (b) pelvic positioning for stability and mobility, and (c) proceeding with adequate body alignment.

Occupational therapists and physical therapists are the main responsible for defining the most adequate implantation in the children's sitting positions[10] **(B)**.

The seats, for children with CP in classroom, during school activities, require an appropriate pelvic anteroposterior angle, i.e., that there is a capacity for forward and backward tilt in relation to the middle line. The appropriate anteroposterior angle of pelvic tilt will position body and upper limb weight on the seat's support base, in a position relative to the hip that allows control of forward and backward pelvic movement. The pelvis may then act as a stable and comfortable base for trunk positioning and ease upper limb mobility during functional activities[10] **(B)**.

It suggests that the child with CP must be seated in neutral position or light pelvic anterior tilt, in order to experiment the positive effects of the seats. The gravity center must be, either directly, or, slightly, forward to ischiatic tuberosity, thus allowing the pelvis to act as a support point for the movement of upper body in a safe and stable manner[10] **(B)**.

Distinct study compared two types of school furniture. Participated in this study children (n = 22), being classified, with diplegia (n = 14), hemiplegia (n = 12), and tetraplegia (n = 2) with GMFCS levels I or II, aged between six to eight years. In this study two types of school furniture were selected:

- School furniture A: School chair with seat with 15° anterior tilt, and seat height individually adjusted, so that the patient would seat, symmetrically, with hip angle at 100°, knee at 135° and the feet totally planted on the ground. One table individually adjusted for each child having a surface with 10° tilt from the horizontal. The table had a semicircular cut-out in order to offering trunk lateral support. Chair and table were individually adjusted for each child.
- School furniture B: School chair with 40.6 seat height, and posterior 5° posterior tilt of the seat. Table with flat, regular, and horizontal surface with adjustable height ranging from 5.1 to 7.6 cm, being individually adjusted for elbow support. American standard size school furniture.

For the functional assessment of upper limb it was used the *Minnesota Handwriting Assessment*, MHA. No statistical evidence of immediate change was observed in writing legibility in both types of furniture. In the same manner, secondary writing results involving four categories of quality, shape, size, alignment, and spacing, did not show any evidence of change in performance quality due to the intervention[11] **(A)**.

It is verified the need of offering a minimum time of five to six weeks so that the children get used to the adapted furniture, and, possibly, to benefit from intervention. Differences in results may be obtained. It is necessary that future researches be directed to explore design influence in school furniture, sitting posture and functional performance. We still know little about the effectiveness of the environment and of interventions intended to improve quality of caligraphy in children with cerebral palsy, other experiments must be conducted to test the long term effect[11] **(A)**.

Recommendation

Table: It is recommended that a cut-out table be used to offer better lateral trunk and upper limbs support during calligraphy activity for students with CP with spastic tetraplegia, athetoid tetraplegia, and hemiplegia[7,8] **(B)**. Children with CP with diplegia, hemiplegia, and tetraplegia with GMFCS levels I or II did not show differences in upper limb functional performance regarding regular table and cut-out tilted table[11] **(A)**. It is observed that patients who use wheelchairs may use cut-out table adaptation attached to the wheelchair's arm support as a tray.

Chair: Study suggests that 5° anterior tilt of the chair seat may difficult postural stability, with no improvement in upper limb functional performance[9] **(B)**. CP children with diplegia, hemiplegia, and tetraplegia with GMFCS levels I or II did not verify differences between chair with 15° anterior tilt of the chair seat compared to chair with 5° posterior tilt[11] **(A)**. It is necessary to understand and consider each patient's needs, due to the heterogeneity of CP children, which requires that the functional seat be individually defined. The appropriate chair must offer conditions for the support of body weight, the hip must be positioned for stability as well as mobility, and the body must be correctly aligned[10] **(B)**.

4. What is the benefit of the home occupational therapy program?

Neuropediatrists and physiatrists refer children with Cerebral Palsy to rehabilitation with Occupational Therapists. However, there is not always possibility of care. Therefore, many times a home occupational therapy program is used. This study aimed to assess the effectiveness of home occupational therapy by comparing with the patients that did not participate in this program by means of parents' satisfaction. Thirty-six children with CP aged between four to twelve years performed, *Gross Motor Function Classification System*: level I, 47%; level II, 14%, level III, 16%, level IV, 7%; V level, 16%; spasticity, 85%; dyskinesia, 14%; ataxia, 3%. The children were ramdomly and equally distributed: Group A, eight weeks of home occupational therapy, Group B, four weeks of home occupational therapy, and Group C, no home occupational therapy. Assessed by means of the Canadian Occupational Performance Measure[12] **(A)**.

This program is divided into five steps: (1) establishment of the collaboration of relationship between parents and therapist, (2) definition of therapeutic goals, mutually, combined with the child's family, (3) selection of therapeutic activities directed for gains and performance of the proposed goals, (4) support to parents by means of home visits, health education, capacitation of caregivers and updates to maintain progress and motivation for the program, and (5) evaluation and re-evaluation[12] **(A)**.

Results indicate there were statistically significant differences between groups A and B, children who had home occupational therapy for eight or four weeks compared to group C, of children who did not have the home program[12] **(A)**, regarding gains in upper limb function and quality of movement. Physicians should consider in the prescription a program with minimum duration of eight weeks from the previous definition of therapeutic goals and may suggest a frequency of 17.5 times a month and with average duration of 16.5 minutes per session[12] **(A)**.

The patients who participated in the home occupational therapy program could count with the support and intervention of their parents as acting parts and participants of their children's rehabilitation process. The success of this program is due, not only to the parents' adherence as caregivers, but also to the critical contribution in the effective role of partners in the rehabilitation process[12] **(A)**.

Recommendation

The home occupational therapy program for upper limb functional gains must be suggested to parents with a prescription of minimum duration of eight weeks, 17.5 times a month in sessions of average duration of 16.5 minutes[12] **(A)**.

5. Sensory integration in children with cerebral palsy is better in individual or group sessions?

In children diagnosed with Cerebral Palsy of the type diparetic spastic, of both genders, aged in average seven years with sensory integrative dysfunction, submitted to individual assessment before and after treatment by means of the Ayres *Southern California Sensory Integration Test*, by performing a program of sensory-percepto-motor training, composed of entry activities, hand cart, hand-walking, and swimming; body conscience activities such as game, pushing the body and, also, activities of the vestibular system, such as jumping on a trampoline, climbing for one hour and a half, three times a week, during three months, show improvement with individual as well as group sessions[13] **(B)**.

Recommendation

Sensory integration in children with Cerebral Palsy of the type diparetic spastic aged in average seven years, with duration o fone hour and a half, three times a week, during three months, is recommended for individual or group execution[13] **(B)**.

6. On children with cerebral palsy, does the use of constraint-induced therapy improve paretic upper limb motor function?

The use of constraint-induced therapy in children with cerebral palsy for six hours a day in combination with a one-hour home exercises program, during one week, extended to two daily hours during six months after intervention, improves movement efficiency, performance, and perception of the studied upper limb, remaining after six months from the start of constraint at home. There is need of more studies regarding this theme, since those are restricted[14] **(B)**.

Recommendation

Constraint-induced therapy improves motor function and perception of the affected upper limb in children with cerebral palsy, submitted to the intervention for six hours a day, associated with the performance of daily home exercises for one hour[14] **(B)**.

7. Is there benefit in the use of kinesio taping associated with conventional rehabilitation therapy regarding functional gain in children with cerebral palsy?

The use of *Kinesio Taping* as sensorimotor stimulation for improvement in trunk control in the sitting position in eighteen children with cerebral palsy of the type spastic tetraparesia, aged between three and thirteen years, male and female, with GMFCS up to level IV in evaluation, who performed physical therapy at least once a month, with need of help to sustain a sitting position in school chair and who had not participated in any previous study with Kinesio Taping. It showed to be ineffective in patients with spastic tetraplegia and/or greater cognitive impairment to help in the alignment of sitting posture in comparison with the benefit identified in children with tetraplegia of the type athetoid[15] **(B)**.

Recommendation

The use of *Kinesio Taping* associated with physical rehabilitation treatment does not lead to significant differences over time, when performed in the paravertebral region of children aged between three and thirteen years with Cerebral Palsy of the type athetoid tetraplegia, with GMFCS up to level IV, during twelve weeks, with periods of use of seventy-two hours, twice a week. It does not lead to positive changes in postural control, remaining, solely, with a subjective observation that the athetoid child would have benefit on the paravertebral region[15] **(B)**.

8. Are upper limb orthoses beneficial for children with cerebral palsy?

Children with Cerebral Palsy with Quadriplegia and Hemiplegia, aged between eight and fifteen years, with spastic hypertonia, dystonia, and rigidity of muscle tone. They were divided into two groups of children with CP. The first group used neoprene orthosis, approximately, six hours a day, five days a week over three months. The second group, the control group, composed of children with cerebral palsy, did not use neoprene orthosis[16] **(B)**.

There was significant decrease in time of movement during the performance of tasks (p = 0.002). Expressive differences were observed for normalization of muscle spasms with the use of orthosis (p = 0.002). It was verified, in the study, a decrease in muscle spasms for children with dystonia (p = 0.001) and spastic hypertonia (p = 0.016)[16] **(B)**.

To verify the effectiveness of thermoplastic orthosis with children with CP quadriplegia and hemiplegia aged one to eight years, the children were analyzed over a nine-month period, divided in two groups:

- Group - I: performed intensive therapy twice a week for forty-five minutes and used orthosis for thirty minutes a day.
- Group - II: performed intensive therapy twice a week for forty-five minutes with no use of orthosis.
- Group - III: regular therapy once a week for forty-five minutes with use of orthosis for fifteen minutes, three times a week.
- Group - IV: regular therapy once a week for forty-five minutes with no use of orthosis.

The results of this study indicate that the use of orthosis combined with therapy shows significant improvement in upper limb quality of movement for wrist extension. With the removal of the orthosis after three months occurs the reduction of benefit over time. It is perceived the need to use orthosis for a long time to maintain quality and amplitude of movement. Suggesting that intensive therapy combined with thermoplastic orthosis promotes a better benefit than isolated intensive therapy or regular therapy and use of orthosis[17] **(A)**.

CP children with hemiplegia and quadriplegia aged one year and a half to four years during a four-month period were analyzed. They were divided into two groups: Group A, performed intensive therapy twice a week in forty-five-minute sessions combined with the daily use of thermoplastic orthosis for thirty minutes, and Group B, control, had regular therapy once a week for forty-five minutes without using orthosis. The results of this study indicate that there were no differences in upper limb motor function and quality of movement when compared to children who received neurodevelopment therapy and use of orthosis or regular therapy[18] **(A)**.

Recommendation

For children with CP with quadriplegia and hemiplegia aged one year and a half to eight years with the daily use of thermoplastic orthosis during thirty minutes combined with therapy twice a week, with duration of forty-five minutes during a nine-month period, it was verified the upper limb motor benefit[17] **(A)**. Children with quadriplegia and hemiplegia aged one and a half to four years making use of thermoplastic orthosis for thirty minutes daily combined with therapy twice a week for forty-five minutes over a four-month period no differences were verified in motor performance[17] **(A).** Considering that children from four years on start to develop their uni and bimanual fine motor coordination skills.

On children with CP and, dystonia quadriplegia, and hemiplegia aged eight to fifteen years, making use of neoprene orthosis for six hours a day during a three-month period, it is observed the reduction in muscle spasms[16] **(B)**.

9. Does the use of ventral support wrist and fingers-positioning orthosis after application of botulinum toxin to the upper limb reduce spasticity?

Spasticity is an importante factor that interferes in movements and posture. The limitation in joint amplitude of movement and inability to perform selective movements may be caused by deformities in upper limbs and by spasticity.

The injection of type A botulinum toxin, may cause muscular relaxation, being effective in promoting muscle tone reduction and, also, potentializing effects in the improvement of motor control in children with hypertonia.

Orthoses may be used to stretch the muscles, being appropriate for joint and bone alignment. Contribute with stretching and maintenance of muscular extension promoting joint stabilization, function, and biomechanical support.

In a study involving children with CP spastic hemiplegia (n = 20) that received the application of toxin in the muscles: pronator, brachioradial, and thumb adductor. It was verified that after two months from application of type A toxin the children who used orthosis during the night, daily, Group A, obtained a 15% improvement, and the children who did not use orthosis during the night, Group B, had a 12.2% improvement. After six months the children were reevaluated and, the Group A, showed a 15.9% improvement and, Group B, 4.2%. The children in Group A, used thermoplastic ventral support wrist and finger positioning orthosis, daily during the night[19] **(A)**.

Distinct study was conducted with CP children with hemiplegia (n = 20) aged four to nine years with spastic hemiplegia. In this study, all children were included in physical therapy for thirty minutes and occupational therapy also for thirty minutes, three times a week during six months. All of them also used thermoplastic orthosis with forearm and neutral position of the wrist with 20° extension with thumb in abduction during the night. The children were divided into two groups, the control performed only therapeutic program (PT/OT) and the control group received application of toxin + therapies. They received the application of type A botulinum toxin in the following muscles: adductor of thumb (10 U), flexor of the wrist (2 x 20 to 2 x 50 U) and pronator teres (30 to 50 U), other muscles in which the application was less frequent: radial flexor of the wrist (30 to 2 x 30 U), brachial biceps (2 x 20 to 2 x 50 U), brachioradial (40 to 2 x 40 U) and flexor of thumb (5 U)[20] **(A)**.

This study's assessments were performed two weeks before the application of toxin, two weeks after the application, and at three, six, and nine months after the start of therapy. At six months the therapy program ended following a period of three months without. For the assessment, were used goniometry, Ashworth scale and The Melbourne Assessment of Unilateral Upper Limb Function. The results indicate improvement in both groups regarding clinical measurements for muscle tone, and active amplitude of movement of wrist and elbow. However, no significant differences were found between the groups in any outcome after six months. No evidence was found for the benefits with application of toxin regarding function and strength[20] **(A)**.

A different study compares the effects of low and high doses of type A botulinum toxin to improve upper limb function with children aged two and a half to twelve years with CP spastic hemiplegia and tetraplegia, double-blind, randomized, and controlled. The group of high dose of toxin in the following doses: biceps 2 U/kg, brachioradial 1.5 U/kg, 3 U/kg radial flexor of wrist, pronator teres 1.5 U/kg and adductor of thumb/opposing 0.6 U/kg at a maximum of 20U. The group of low dose received 50% of this dose. The patients had occupational therapy for three months. The results were measured at the start, within one and three months after injection, and it was observed that there was no significant difference between the low and high dose groups regarding upper extremity function during the three-month period measured by the Quality of Upper Extremity Skills Test ($p = 0.68$). There was no difference between groups in the Pediatric Evaluation of Disability Inventory ($p = 0.83$). Although the prehension strength decreased during the three-month period, there was no difference between groups (p = 0.51). These findings indicate that there is no difference in hand and arm function between a low or high dose of toxin within one and three months after injection. This information may be used to orient the application of toxin in upper limb[21] **(B)**.

Twenty studies included in the metanalysis were analyzed. Six of them report zero adverse effects. Thirty-five different adverse effects were reported. Type A botulinum toxin, was related to infection in the respiratory tract, bronchitis, muscular weakness, pharyngitis, ashtma, urinary incontinence, falls, convulsions, fever and non-specified pain. Concluding that type A botulinum toxin has a good safety profile during the first months of use. However, the occurrence of adverse events is more frequent among children with cerebral palsy compared to individuals with other health conditions. Severe adverse effects are, potentially, related to the use of type A botulinum toxin, being necessary to broaden the studies in order to clarifying the causal relationship[22] **(B)**. Age and functional classifications and/or diagnoses of the children with CP analyzed in the studies were not described.

Recommendation

Children with CP who received application of toxin in UULL and made use of wrist and finger positioning orthosis, and the children who had occupational therapy and physical therapy once a week plus the use of orthosis had the same gains for alteration of muscle tone and active movement for wrist and elbow[20] **(A)**. After the application of Type A botulinum toxin and nightly use of thermoplastic wrist and finger positioning orthosis for alteration of spasticity[19] **(A)** no evidences were found to indicate functional differences in hand and arm between the application of high or low dose of toxin[21] **(B)**. Concluding that type A botulinum toxin has a good safety profile during the first months of use. However, the occurrence of adverse events is more frequent among children with cerebral palsy than on individuals in other health conditions[22] **(B)**.

10. What is the benefit of application of botulinum toxin combined with conventional therapy regarding upper limb functional gain in patients with CP?

On children diagnosed with Cerebral Palsy (CP) of the type spastic hemiparesia with degree two or higher in the Modified Ashworth Scale in elbow, wrist or thumb, total passive amplitude of movement and ability to initiate, actively, finger movement, in Occupational Therapy (OT) session once every two weeks, during six months associated with the application of type A botulinum toxin (BTX/A) in dose of 2 to 6 U/kg, in at least one of three muscle groups, biceps, ventral forearm muscles or adductor of thumb, improves function quality after one month, remaining during six months. The prehension strength decreased after one to three months of BTX/A application, but normalized after six months[23] **(B)**.

OT care, in combination with BTX/A application in one single session in flexors of the elbow; forearm pronators; flexors and extensors of wrist; flexors of fingers; adductor, opposing and flexor of thumb, with maximum dose of 8 U/kg, dilution of 100 U in 0.5 ml of physiological saline, with sedation, local anesthesia, and analgesia, benefitted the children with CP regarding quality of movement and function of upper limb during six months[24] **(B)**.

On children with CP spastic, with impairment of one or both UULL, degree two or three on the Modified Ashworth Scale in at least one muscle group, OT care for one hour/week during twelve weeks associates with single application of BTX/A with maximum dose of 2 to 13 U/kg in greater and smaller pectoral; dorsal; teres major; pronator quadratus and pronator teres; brachioradial, biceps; brachial; radial and ulnar flexors of wrist; superficial and deep flexors of fingers; lumbricals; long flexor of thumb; adductor and opposing of thumb, leads to the decrease of muscle tone and functional improvement two weeks after the injection which returned to basal level after six months[3] **(B)**. When the OT program is performed one hour a week during four weeks and the BTX/A application in upper limb does not exceed the dose of 12U/kg and maximum 300U of Botox®, dilution of 100U/ml of physiological saline, there is improvement of body scheme, participation on activities and self-perception[25] **(B)**.

The application of type A botulinum toxin with dosage of 2 to 3 U/kg per muscle of the arm and 1 to 2 U/kg per muscle of the forearm, with a maximum of 50U, dilution of 5 U/0.1 ml - adductor of thumb (10 U), ulnar flexor of wrist (2 x 20 U to 2 x 40 U), pronator teres (30 to 50 U), radial flexor of wrist (30 to 2 x 30 U), brachial biceps (2 x 20 to 2 x 50 U), brachioradial (40 to 2 x 40 U), and short flexor of thumb (5 U) - in combination with Physical Therapy and Occupational Therapy sessions during thirty minutes each and frequency of three times a week over six months in children with CP of the type spastic hemiparesia, did not show any significant clinical difference during nine months. However, BTA/X does not improve function or muscular strength[20] **(B)**.

The reapplication of type A botulinum toxin in three cycles every sixteen weeks on the same muscle group in the dose of 0.5 U/kg for the adductor of thumb, long flexor of thumb, and superficial flexor of fingers; 1 U/kg for the deep flexor of fingers, radial flexor of wrist, ulnar flexor of wrist, and pronator quadratus; and 2 U/kg for the brachial biceps, dilution of 10 U/0.1 ml, combined with Occupational Therapy sessions twice a week during six weeks progressively reduces spasticity on the pronators of forearm, average difference of 50.0 degrees (CI 95% 22.4-77.6 and flexors of wrist, with average difference of 20.9 degrees (CI 95% 2.4-39.4, as well as improvement in the parents' perception regarding the children's performance, although it does not improve quality of movement and fine motor performance of the UL, with no significant differences regarding satisfaction studied in several instruments[26] **(B)**. The standard Physical Therapy and Occupational Therapy program of thirty minutes each, three times a week, during six months, combined with the night use of thermoplastic orthosis aiming improvement of passive AOM, elbow extension, forearm in neutral, wrist extension in 20° and thumb abduction, increases the active amplitude of movement of the wrist and decreases Ashworth Scale score, being that the gain obtained decreased after three months of completion. Conventional therapy associated with BTX/A application, dilution 5 U/0.1 ml; dosage 2-3 U/kg in the arm and 1-2 U/kg in the forearm, in the adductor of thumb (10 U), ulnar flexor of the wrist (2 x 20-2 x 40 U) and pronator teres (30-50 U), predominantly, and with less frequency in radial flexor of wrist (30 - 2 x 30 U), brachial biceps (2 x 20-2 x 50 U), brachioradial (40-2 x 40 U) and short flexor of thumb (5 U) improves speed of movement of upper limb, but decreases manual dexterity[27] **(B)**.

Recommendation

The application of type A botulinum toxin combined with conventional therapy on the muscles brachial biceps; brachioradial; pronators of forearm; unlar flexor of wrist; radial flexor of wrist; superficial and deep flexors of fingers; adductor, opposing and flexor of thumb is recommended for functional gain of upper limb in children with cerebral palsy[20,23-27] **(B)**.

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