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ORIGINAL ARTICLE

The use of surface electromiography as a measure of physiotherapy outcomes in children with Cerebral Palsy: a systematic review

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Abstract

Introduction: Cerebral Palsy is the most common physical disability in childhood. Physical therapy plays a central role in managing the treatment of disease sequelae. However, it is always a challenge to quantify the results obtained in physical therapy interventions. Thus, surface electromyography has been increasingly used by physiotherapists because it is a quantitative method of evaluation and treatment of neuromuscular system dysfunctions.

Objective: To analyze the use of surface electromyography as a physical therapy outcome measure in children with cerebral palsy.

Methods: From the search in two important databases, clinical trials of physical therapy interventions that used surface electromyography as a physiotherapy outcome factor in children with cerebral palsy, published in Portuguese, English, French or Spanish until August 2019, were selected.

Results: A total of 166 articles were found in the databases searched. Of these, only 15 were included and classified with good methodological quality by PEDro and because they were related to surface electromyography. A flowchart with standardization of actions was built taking into account the most prevalent findings in the studies.

Conclusion: Surface electromyography has been applied by physiotherapists to evaluate the effects of the intervention, but it is necessary to improve its level of evidence.

Keywords: Cerebral palsy, physiotherapy, electromyography.

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Authors summary

Why was this study done?
It is understood that the approach of various methods, techniques and concepts within the field of physical therapy should be based on scientific evidence, thus favoring clinical practice.
Electromyography is a very relevant tool for these findings in neuromuscular system dysfunction. And more and more physiotherapists yearn for answers that may help in treating their patients. In this case, we study cerebral palsy (CP).
Through the electromyographic signal it is possible to study the response to the therapeutic exercises commonly used in rehabilitation regarding the beginning and end of the activity, type of muscle contraction and joint position.

What did the researchers do and find?
Of the 155 articles found, only 15 were included in a systematic review, which demonstrated the importance of using EMG in physical therapy practice as an outcome, with rigorous methodological content.
Analyzing the 15 articles, only one article received a score of nine according to the PEDro Scale, most were scored four or five on the scale.
Four analyzed muscle activation in isometric exercises, six used isotonic exercises and only one article used isokinetic exercises. Two articles evaluated EMGs during isotonic and resting exercises. One article evaluated isotonic exercises and also during balance exercises and one article evaluated EMGs during manipulations performed by the evaluator.

What do these findings mean?
These findings mean that EMGs has been used by physiotherapists to demonstrate muscle response to neural stimuli in a non-invasive manner.
Through the EMGs it is possible to observe the degree, duration, type of muscle contraction, alteration of the composition of the motor units resulting from muscle training programs, recruitment neural strategies, as well as allowing inferences related to muscle fatigue.
It also means that the electromyographic signal becomes a useful tool for analyzing the outcome of physiotherapeutic treatments because it provides easy access to the physiological processes that make the muscle generate strength, produce movement, and perform numerous functions that allow us to make relevant inferences regarding biomechanics of human movements.
The novelties of these findings indicate that EMGs can be used as an indicator of the onset of muscle activation (as found in most studies), its relationship to the force produced and its use as an index of fatigue processes. As muscle strength increases, signal amplitude increases correspondingly, and in dexterity tasks, it suggests better postural control.

INTRODUCTION

Cerebral Palsy (CP), also known as chronic non-progressive childhood encephalopathy, refers to a heterogeneous group of permanent but non-progressive movement and posture disorders caused by fetal or developing infant brain injury[1]. It is the most common motor disability in childhood. The US Centers for Disease Control and Prevention estimates that, on average, one in 323 children in the country has CP[2]. In Europe, however, it is estimated that 2 to 3 cases per 1000 live births have encephalopathy[3]. In underdeveloped countries the rate reaches 7 per 1,000 live births. And in Brazil, the incidence of the disorder is 30,000 to 40,000 new cases per year[4].

Children with CP may have sensory, cognitive, communication and behavioral deficits[1]. Although not a progressive disorder, musculoskeletal changes occur over time, such as: spasticity, loss of range of motion, contractures, deformities and mobility difficulties, causing limitations in the child's daily life activities and even complete functional dependence on caregivers and family members[5]. Because of their serious long-term consequences, effective interventions can help improve the motor function, quality of life and independence of these children1. In this sense, physiotherapy plays a central role in managing the treatment of CP sequelae by focusing on functionality, movement and optimal use of the child's potential. Physical therapy uses physical approaches to promote, maintain and restore physical well-being, which in turn will also be able to generate psychological and social well-being[6].

Previous reviews have addressed the effectiveness of physiotherapy interventions for children with CP, focusing on treatment through the Bobath neuroevolutionary concept[7], strength training[8], gait training[9], mirror therapy[10], whole body vibration[11], equine therapy[12], among others, demonstrating positive data on these therapies.

However, it is always a challenge to be able to quantify the results obtained in physical therapy interventions. This is justified by the large number of studies on neurofunctional physical therapy with methodological poverty. Physical therapists need to take responsibility for using evidence-based practices and objective methods of intervention and measurement of the evolution of their neurological patients[13].

Thus, surface electromyography (EMGs) has been increasingly employed by physiotherapists because it is a quantitative method of evaluation and treatment of neuromuscular system dysfunction. There are many clinical dilemmas experienced by physiotherapists who yearn for answers that may help the treatment of their CP patients, combining practice with clinical evidence. Through the electromyographic signal it is possible to study the response to therapeutic exercises commonly used in rehabilitation regarding the beginning and end of the activity, type of muscle contraction and joint position. The EMGs is a technique that allows to analyze the muscular function in certain tasks and also to evaluate the effectiveness of functional recovery techniques of the most varied pathologies, besides being used to assist the training of specific muscles (biofeedback). Thus, EMGs allows numerous applications in both clinical and research[14].

Thus, the search and analysis of studies that demonstrate the importance of the use of EMGs in physiotherapeutic practice, with rigorous methodological content and that, in fact, improve the way to measure the results of physiotherapy, would be of fundamental importance.

Thus, the aim of this study was to analyze the use of EMGs as a measure of physical therapy outcome in children with CP.

METHODS

This review was conducted in accordance with the guidelines for systematic reviews Preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA). The sample consisted of clinical trials of physical therapy interventions that used EMGs as a physiotherapy outcome factor in children with CP.

Eligibility criteria

Clinical trials from 2000 to 2019 with CP children aged two to 18 years were included. In the trials the EMGs was used as a way of evaluating some physiotherapeutic treatment. Trials that provided other adjuvants to physical therapy, such as selective dorsal rhizotomy, botulinum toxin or baclofen injection therapy, and surgical or pharmaceutical interventions were excluded.

Search strategy

The search was performed from May 2017 to August 2019 in Pubmed databases without language restriction, using the following advanced search strategy: cerebral palsy AND physical therapy modality AND electromyography. The Emabse database could not be accessed.

Study selection and data extraction

After the search, two independent evaluators made the selection of articles by reading titles and abstracts. All articles that were previously selected were read in full by both reviewers to verify that they met the review eligibility criteria. When there was disagreement between the evaluators, this were resolved by consensus.

Data extraction was through a standardized form also by two independent reviewers. Information on sample, evaluations, time and type of intervention that favored motor development were extracted. If in doubt, the authors of the original articles were contacted.

Bias risk assessment and data analysis

Bias risk assessment was performed by both evaluators independently using the PEDro Scale[15]. The scale assesses internal validity (group randomization, concealment of group distribution, initial group comparability, group, therapist and patient blindness, “intention-to-treat” analysis and adequacy of follow-up period) and interpretability of data (existence of statistical comparisons between groups, estimates and measures of variability) through 10 criteria[15]. When there was disagreement between the evaluators, this were resolved by consensus.

RESULTS

Of the 166 articles found in both databases, only 15 articles met the inclusion criteria and were selected. The entire article selection process is shown in Figure 1.

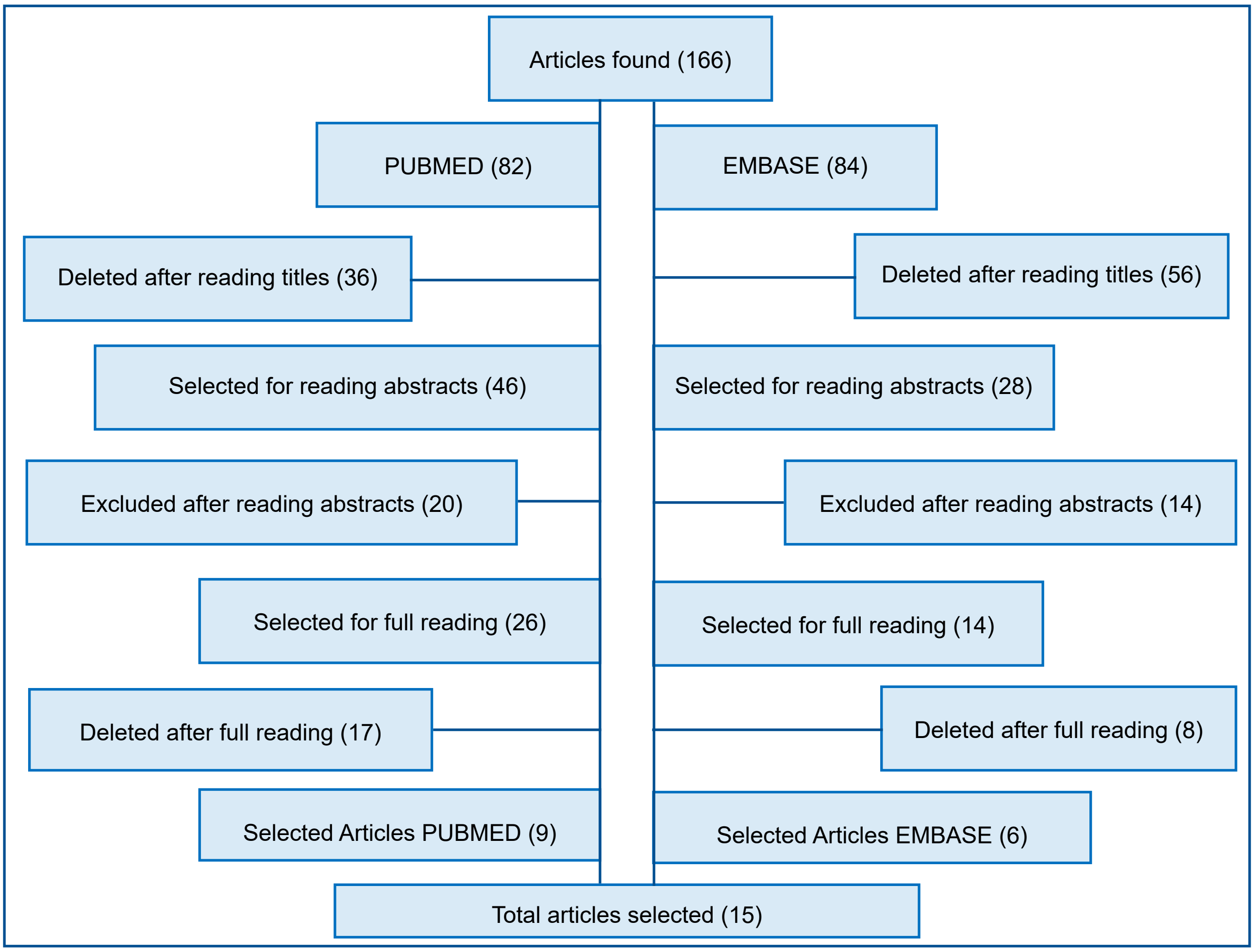

Figure 1: Flowchart of the article selection process.

Each of the 15 selected articles was evaluated for their methodological quality according to the PEDro[14] Scale. Only the article by McGibbon *et al.*[16] received a score of nine and most articles scored[17-30] four or five on the scale, as can be seen in Table 1.

Table 1: Presentation of PEDro scale score for each article.

n°	Articles	PEDro
1	The effect of quadriceps femoris muscle strengthening exercises on spasticity in children with cerebral palsy.[17]	4
2	Improvements in Muscle Symmetry in Children with Cerebral Palsy after Equine-Assisted Therapy. [18]	6
3	Changes in soleus H-reflex modulation after treadmill training in children with cerebral palsy.[19]	5
4	Effects of constraint-induced movement therapy on hand skills and muscle recruitment of children with spastic hemiplegic cerebral palsy.[20]	3
5	Immediate and long-term effects of hippotherapy on symmetry of adductor muscle activity and functional ability in children with spastic cerebral palsy.[16]	9
6	Effects of weight resistance on the temporal parameters and electromyography of sit-to-stand movements in children with and without cerebral palsy.[21]	5
7	Effects of weight resistance on the temporal parameters and electromyography of sit-to-stand movements in children with and without cerebral palsy.[22]	3
8	Electromyographic analysis of quadriceps muscle among children with cerebral palsy underwater and on dry ground.[23]	4
9	Anticipatory and compensatory postural adjustments in sitting in children with cerebral palsy.[24]	4
10	Surface EMG analysis and changes in gait following electrical stimulation of quadriceps femoris and tibialis anterior in children with spastic cerebral palsy.[25]	5
11	Humeral external rotation handling by using the Bobath concept approach affects trunk extensor muscles electromyography in children with cerebral palsy.[26]	5
12	Facilitation handlings induce increase in electromyographic activity of muscles involved in head control of cerebral palsy children.[27]	6
13	Muscle Recruitment and Coordination following Constraint-Induced Movement Therapy with Electrical Stimulation on Children with Hemiplegic Cerebral Palsy: A Randomized Controlled Trial.[28]	6
14	Evaluation of Functional Mobility Outcomes Following Electrical Stimulation in Children with Spastic Cerebral Palsy.[29]	4
15	Analysis of the electromiographic activity of lower limb and motor function in hippotherapy practitioners with cerebral palsy.[30]	5

The selected articles surveyed 325 children with CP. Of these articles, three used a control group (CG) with typically developing children with no neurological impairment, totaling 58 healthy children, while one article composed its CG for eight children with mild cognitive impairment and motor development according to their age. Children's ages ranged from two to 18 years. As for tone, all children with CP had spastic tone. Regarding CP topography, seven studies evaluated diplegics, three evaluated hemiplegics, one evaluated quadriplegics, two studies evaluated hemiplegics and diplegics, and only one study evaluated quadriplegic, hemiplegic and diplegic children. Regarding motor level, according to the Gross Motor Function Classification System (GMFCS)[30], eight articles analyzed children with GMFCS I to III, in one article GMFCS ranged from I to IV while in another article the variation was between I to V. Two articles used the Manual Skill Rating System (MACS)[31] to classify children because they analyzed upper limb muscle EMGs. The classification varied from I to III in one article and from I to II in another. And two articles did not use any of the classifications to characterize their sample. Table 2 presents the articles that were part of this research..

The 15 articles found bring several physical therapy techniques used in the rehabilitation of children with CP that were evaluated by EMGs, as shown in Table 3.

The acquisition of the electromyographic signal detected through electrodes placed on the surface of the muscle overlying skin can be done in various types of postures, movements and exercises, whether isometric, isotonic or isokinetic[31].

Of the 15 articles selected, four analyzed muscle activation in isometric exercises, six used isotonic exercises and only one article used isokinetic exercises. Two articles evaluated EMGs during isotonic and resting exercises. One article evaluated isotonic exercises and also during balance exercises and one article evaluated EMGs during manipulations performed by the evaluator.

Table 2: Characteristics of the studies analyzed.

nº	Authors/Year	Sample	Intervention	Outcome	Results
1	Fowler et al.[17]	GI: 24* GC:12**	Both groups performed isometric, isotonic and isokinetic exercises to strengthen the femoral quadriceps with maximum efforts.	Muscle activity during VL, medial hamstring, medial gastrocnemius and anterior tibialis pendulum testing.	There was no ↑ of spasticity (p>0.05).
2	Benda et al.[18]	15	GI: A session of equine therapy. GC: Sitting in a barrel.	Trunk and lower limb muscle activity during sitting, standing and walking tasks.	Improved adductor symmetry in the GI. (p = 0.051).
3	Hodapp et al.[19]	7	GI: Treadmill training for 10 min in 10 days.	Soleus muscle activation during gait.	No significant differences during gait were find (p = 0.50).
4	Stearns et al.[20]	6	GI: IRD for 2 weeks.	Recruitment and muscle activation of the major pectoralis, long triceps head, upper trapezius, anterior and middle deltoid, long biceps head, ulnar flexor and radial carpal extensor.	↑ activation in grip and ↓ activation in dexterity tasks, suggesting better muscle control.
5	McGibbon et al.[16]	GI:13* GC: 8**	GI: Equine therapy in 12 sessions. GC: Sitting in a barrel.	Adductor symmetry during walking after training.	Adductor symmetry improvement in GI (p <0.001).
6	Reid et al.[21]	14	GI: Performed MMSS strengthening using eccentric training apparatus. Two more matched groups of typical children who trained and did not train. GC: Not trained.	Biceps brachii and brachioradialis muscle activity during post-training isokinetic evaluations.	↓ co-contraction in children with CP (p = 0.01).
7	Liao et al.[22]	GI:15* GC:15**	Both groups performed the task of sitting and lifting using a vest with 3 types of loads (1RM, 6 RM and 10 RM).	Recruitment of agonists and reaction time in VL, hamstring and gluteus maximus.	GI presented ↑ co-contraction in the VL that the CG.
8	Trócoli et al.[23]	GI:9* GC:11**	Both groups had to get up from a sitting position and walk 3 meters on the ground and in the water.	RF muscle activity.	During underwater activities ↑ RF activation in GI (p = 0.0039).
9	Bigongiari et al.[24]	GI:12* GC:12**	Both groups had to grab a ball from the sitting position.	Electrical activity of the shoulder and trunk muscles.	GI presented ↑ trunk contraction that the CG.
10	Arya et al.[25]	10	GI: Physiotherapy, OT and electrostimulation for 4 weeks. GC: Physiotherapy and OT.	Muscle activation of the anterior femoral and tibial quadriceps after the protocols.	No conclusive answers
11	Santos et al.[26]	40	GI: Key-point elbow (Bobath) facilitation in RI and RE in sitting position.	Muscle activity of trunk extensors.	↑ activity at C4 (p = 0.007) and T10 (p <0.001) in RE manipulation.
12	Simon et al.[27]	31	GI: Hip key point facilitation (Bobath) in 3 positions (DL, DV and DVC).	Paraspinous and sternocleidomastoid muscle activity	↑ muscular activity in DL management at C4 (p <0.001), T10 (p <0.001) and sternocleidomastoid (p = 0.02) levels
13	Xu et al.[28]	68	G1: IRT, electrostimulation. G2: IRT. G3: OT for 6 months.	Recruitment and muscle coordination of wrist extensor flexors when performing maximal isometric contraction.	Group 1 showed ↑ EMG improvement rate at 3 and 6 months (p <0.05).
14	Mukhopadhyay et al.[29]	26	GI: Electrostimulation and physiotherapy for 12 weeks GC: Physiotherapy.	Muscle strength and activation of anterior tibial at rest and ankle dorsiflexion movement.	↑ GI muscle strength (p <0.001)
15	Ribeiro et al.[30]	GI:7* GC:8***	Both groups performed 25 sessions of equine therapy.	RF, VM, VL and TA muscle activation during horseback riding and before and after with the horse stationary.	↑ muscle activity in AT in both groups but without significant difference (p = 0.031).

GI: interventional group; CG: control group; VL: vastus lateralis; MV: vastus medialis; ↑: greater; MMII: Lower limbs, IRT: induced restraint therapy; MMSS: upper limbs; MR: maximum repetition; TA: anterior tibialis; RF: rectus femoris; OT: occupational therapy; IR: internal rotation; RE: external rotation; C4: cervical 4, T10: thoracic 10; DL: lateral decubitus; DV: prone position; CVD: ventral decubitus in the wedge; G: group; EMGs: surface electromyography.
*Children with PC. **Typical children without PC. ***Children with typical motor development but cognitive impairment.

Table 3: Physical Therapy Techniques Evaluated by EMGs in each article.

Physical Therapy Techniques	Articles
IRT	1
IRT and electrical stimulation	1
Electrical stimulation	2
Bobath	2
Strength training	3
Equine therapy	3
Treadmill Training	1
Balance and postural control exercises	1
Underwater and ground exercises	1
Total	15

EMGs: surface electromyography; IRT: induced restraint therapy

DISCUSSION

EMGs have been widely used by physiotherapists precisely because they have the ability to demonstrate non-invasive muscle response to neural stimuli. Through EMGs, it is possible to observe the degree, duration and type of muscle contraction, change in the composition of motor units resulting from muscle training programs, recruitment neural strategies, and allow inferences related to muscle fatigue[32,33]. Thus, there are several applications of EMGs in physiotherapy, either to evaluate the success of a given therapy or to demonstrate differences regarding intergroup and intergroup muscle activation[34].

In patients with CP, where the choice and response to intervention are difficult because the disorder is heterogeneous, presenting various motor and cognitive etiologies and characteristics, different brain injury patterns and associated health conditions, the need to opt for the best therapy. It is extremely important to provide better gains to patients[35,36]. Therefore, the electromyographic signal becomes a useful tool to analyze the outcome of physiotherapeutic treatments because it provides easy access to the physiological processes that make the muscle generate strength, produce movements and perform numerous functions that allow us to make relevant inferences regarding the biomechanics of human movements[34].

Regarding the use of the electromyographic signal, according to De Lucca[35], in biomechanics, there are three types of applications that prevail: its use as an indicator of the onset of muscle activation, its relationship with the force produced and its use as an index of fatigue processes. As an indicator of the onset of muscle activity, the signal may provide the timing sequence of one or more muscles performing a task, such as during walking or maintaining upright posture, for example. In the present study, most articles, ie 13, analyzed the muscle activation process, two articles related the electromyographic signal with muscle strength, and no article analyzed issues related to muscle fatigue.

The relevance of researching muscle activation and strength in children with CP after treatment programs is because muscle weakness is a condition present in this disorder that contributes to abnormal posture and movement. The loss of descending excitatory motor signals in the spinal cortical tract results in reduced activation and muscle size, which is further aggravated by pathological changes in muscle elasticity. Understanding these processes and which therapy enables better muscle activation and strength directs physical therapy work and provides better functional responses for the patient[37].

According to Zhou *et al.*[38], there is a linear relationship between EMGs signal amplitude and muscle contraction force. As muscle strength increases, the signal amplitude increases correspondingly. In the study by Labarre-Vila[39] with healthy college students that aimed to analyze the muscle function of the vastus lateralis (VL), vastus medialis (VM) and rectus femoris (RF) muscles during squats at different angles, the authors observed a decrease in the electromyographic signal with increased time and fatigue at each squat angle.

The research by Nielsen *et al.*[40], points to the relationship that the electromyographic signal may bring about muscle strength and trophicism. The researchers performed training of the anterior tibial muscle in 12 patients with hemiplegia and demonstrated, in their results, an almost linear relationship between EMG amplitude and muscle thickness amplitude for each patient in their affected lower limbs[41].

In the present study, among the results obtained through EMGs, only two articles did not reveal significant electromyographic alterations after the physiotherapy treatment. Hodapp *et al.*[19] used EMGs to examine muscle activation of the soleus muscle during gait in CP children before and after 10-min treadmill training for 10 days. After 10 days, the authors did not find significant differences in absolute values of EMGs during gait ($p = 0.50$).

Arya *et al.*[25] used EMGs to assess muscle activation of the femoral and anterior tibial quadriceps of two groups of CP children before and after a protocol consisting of physical therapy and occupational therapy (OT) for the CG and the two therapies associated with electrical stimulation of the muscles surveyed during gait in the GI. The study found no conclusive responses to muscle activation after four weeks of therapy.

However, Mukhopadhyay *et al.*[29], in their study, employed EMGs to investigate the physiological changes in muscle strength and activation of the anterior tibial muscle at rest and ankle dorsiflexion movement before and after a stimulation protocol, associated with physical therapy in the GI and only physical therapy in the CG, noticed an increase in GI muscle strength (p <0.001) after 12 weeks of treatment.

Xu *et al.*[28], evaluated muscle recruitment and coordination of the flexor and extensor muscles of the wrist when grasping a cylindrical wood fish to produce maximum isometric contraction. Three groups were evaluated, the first group underwent induced restraint therapy (IRT) associated with electrostimulation, the second, only IRT and the third, conventional treatment with O. IRT associated with electrostimulation showed a higher rate of improvement in wrist extensor EMGs compared to co-contraction compared with the other two groups (IRT, OT) at three and six months of treatment (p <0.05).

Still regarding the use of the electromyographic signal to evaluate the benefits of using IRT in patients with CP, Stearns *et al.*[20] evaluated the recruitment and muscle activation of the pectoralis majoris, triceps long head, upper trapezius, anterior and middle deltoid muscles, long biceps head, ulnar flexor, and radial carpal extensor, comparing the maximum voluntary contraction of each of these muscles during functional tests of grip strength, forceps, and dexterity before and after two weeks of intervention. Electromyographic analysis showed a significant increase in muscle activation of the forceps (p = 0.05). Visual inspection of the EMGs data suggested increased muscle activation during grip and decreased muscle activation required during dexterity tasks, suggesting better muscle control.

Simon *et al.*[27] measured the muscle activity of the paraspinal and sternocleidomastoid muscles in children with CP in three positions: DL, DV and CVD. In all positions the therapist utilized hip key point facilitation as advocated by the Bobath Concept. As a result of EMGs, the authors found increased muscle activation when handling was performed in the DL at C4 (p <0.001), T10 (p <0.001) and sternocleidomastoid (p = 0.02) levels. The authors report that manipulations performed on DV may induce facilitated head control, as assessed by cervical and upper trunk muscle activity.

Like the previous study, Santos *et al.*[26] also used EMGs to evaluate the effects of the Bobath Concept in their study. Thus, they measured the muscle activity in the sitting position during the shoulder IR and RE manipulations, which were performed using the elbow joint as the key control point. The research results showed that there was an increase in the electromyographic signal of the trunk extensor muscles at vertebral levels C4 (p = 0.007) and T10 (p <0.001) in the RE position. In the T10 region, there was also increased signal (p = 0.019) in the IR position. These results indicate that shoulder RE management can be used in diplegic children to facilitate cervical and trunk extensor muscle activity.

Regarding equine therapy, McGibbon *et al.*[16] analyzed through EMGs the symmetry of the right and left adductor muscle during the walking of children with CP after equine training for 10 minutes for 12 sessions compared with children who only sat in a barrel during this same period. Study results showed that equine therapy improved adductor muscle symmetry in the children with CP studied (p <0.001).

Similarly, Benda *et al.*[18] used EMGs to measure trunk and lower limb muscle activity during tasks performed in sitting, standing and walking positions. The GI was evaluated before and after a riding therapy session and the CG before and after sitting in a barrel. The authors observed a significant improvement in the symmetry of hip adductor muscle activity after equine therapy (p = 0.051). No significant changes were observed in the group sitting on the barrel. According to the authors, these results suggest that horse movement, unlike passive stretching, explains the improvements observed.

Still on equine therapy, Ribeiro *et al.*[30] measured the activation of the VL, VM, TA and RF muscles at three moments, before and after the horse ride, with the horse still and during the horse ride. GI and CG performed the same training. Electromyographic analysis showed greater activation of AT compared to other muscles, but without showing significant difference. And when comparing the two groups, the GI showed higher muscle activity (p = 0.031).

Fowler *et al.*[17] investigated, through EMGs, muscle activity during the pendulum test to determine whether quadriceps strengthening exercises (isometric, isotonic and isokinetic exercises) would alter the spasticity of the VL, medial hamstring, medial and anterior tibial gastrocnemius muscles. The authors did not find increased spasticity in the muscles surveyed after individuals with CP completed quadriceps femoral muscle strengthening exercises with maximal efforts (p <0.05). They also found no differences in pre and post treatment data regarding the order and type of exercise performed (p> 0.05). Also, according to those responsible for the research, these results, as well as the results of other studies that demonstrated improvements in strength production in individuals with CP, suggest that there are no harmful effects associated with muscle strengthening programs.

Reid *et al.*[21] also used the electromyographic signal to analyze a strengthening program, but only used eccentric exercises. The authors examined flexion activity of the biceps brachii and brachioradialis during isokinetic evaluations before and after a strengthening program using an eccentric upper limb training apparatus. GI was formed by children with CP and CG by children with typical development. Activity recorded by EMGs was elevated before training in children with CP, but decreased after training to levels similar to those of typically developing children (p = 0.01). According to the researchers, the results suggest that eccentric exercise may decrease co-contraction.

Liao *et al.*[22] used EMGs to investigate agonist recruitment and reaction time in the VL, hamstring and gluteus maximus muscles during the sit-up task using a three-load vest (1RM high/max resistance, 6RM moderate resistance, low resistance 10RM). The GI was composed of children with CP and the CG was composed of children with typical development. Children with CP took longer to get up than CG when the load was high (p = 0.004). The VG EMGs peak increased with increasing GC resistance (p <0.017), but not in children with CP. Children with CP had a higher proportion of VT co-contraction than the CG (p = 0.001) at all resistance levels.

Bigongiari *et al*.[24] used EMGs to investigate the electrical activity of the shoulder and trunk muscles in children with CP and without CP by grasping a ball from a sitting position. Children with CP had increased electromyographic signal and higher level of co-contraction (p <0.05). Linear regression indicated a positive relationship between EMGs and aging for the CG, while this relationship was negative for participants with CP. The authors suggest that the main strategy for postural control in children is based on corrections after the onset of movement. The linear relationship between EMGs and aging suggests that the development of postural control is affected by central nerve disease, which may lead to increased muscle contraction.

Trócoli *et al*.[23] investigated through EMGs the muscle activity of the RF muscle while the children got up from a sitting position and also when walking a distance of three meters. GI was formed by children with CP and GI by healthy children. All these activities were analyzed with the participants in soil and aquatic environment, and the level of immersion in the xiphoid process was standardized. Research results showed that during underwater activity there was an increase in RF muscle activation in children with CP compared to healthy children (p = 0.0039). During walking on the ground, muscle activity was higher in the group of children with CP than the CG (p = 0.0014), besides walking underwater (p = 0.007). The study demonstrated greater RF muscle activation in children with CP during underwater walking compared with the group of healthy children.

The research had several limitations: (a) the interventions were distinct; (b) variation in the frequency, duration and timing of interventions; (c) the valuation method differed and the time used for the revaluations. All these aspects prevented a comparability of quality, as well as the fact that some do not describe the results clearly and with statistical basis described. However, the results and limitations show that research with greater methodological rigor, with clearer and less empirical treatment descriptions, is of paramount importance. Another important limitation, which was beyond the control of the authors, was the Embase database from 2017 to 2019 being unavailable in the linked University.

CONCLUSION

The applications of EMGs in physical therapy in children with CP are wide, and most publications focus on the fate of the technique for the study of muscle activation. However, only one article had a good score regarding its methodological quality, which justifies the lack of randomized double blind clinical trials with greater methodological rigor for a better level of evidence. The present article demonstrates that children with CP benefit from the use of EMGs as a physical therapy outcome measure, as the motor activation processes related to motor tasks provide quantitative data that, when analyzed correctly, can provide important information that will help in the biomechanics analysis of human movement and that will make the clinical practice of the physical therapist more integrated with the scientific evidence.

Abbreviations

PC: Cerebral Palsy; EMGs: Surface Electromyography; GMFCS: Gross Motor Function Classification; MACS: Manual Skill Rating; GI: interventional group; CG: control group, VL: vastus lateralis; ↑: larger; Lower limbs, IRT: induced restraint therapy; Upper limb: upper limbs; MR: maximum repetition; RF: rectus femoris; OT: occupational therapy; IR: internal rotation; RE: external rotation; C4: cervical 4, T10: thoracic 10; DL: lateral decubitus; DV: prone position; CVD: ventral decubitus in the wedge; G: group; MV: vastus medialis.

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Resumo

Introdução: A Paralisia Cerebral é a deficiência física mais comum na infância. A fisioterapia desempenha um papel central na gestão do tratamento das sequelas da Paralisia Cerebral. Contudo, é sempre um desafio conseguir quantificar os resultados obtidos nas intervenções fisioterapêuticas. Dessa forma, a eletromiografia de superfície vem sendo cada vez mais empregada por fisioterapeutas por ser um método quantitativo de avaliação e tratamento das disfunções do sistema neuromuscular.

Objetivo: Analisar o uso da eletromiografia de superfície como medida de desfecho da fisioterapia em crianças com paralisia cerebral.

Método: A partir da busca em duas importantes bases de dados, foram selecionados ensaios clínicos de intervenções fisioterapêuticas que utilizaram a eletromiografia de superfície como fator de desfecho da fisioterapia em crianças com paralisia cerebral, publicados em português, inglês, francês ou espanhol até agosto de 2019.

Resultados: Foram encontrados 166 artigos nas bases consultadas. Desses, somente 15 foram incluídos e classificados com qualidade metodológica boa pelo PEDro e por terem relação com a eletromiografia de superfície. Um fluxograma com padronização das ações foi construído levando em consideração os achados mais prevalentes nos estudos.

Conclusão: A eletromiografia de superfície vem sendo aplicada pelos fisioterapeutas para avaliar os efeitos da intervenção, mas precisa melhorar seu nível de evidência.

Palavras-chave: Paralisia Cerebral, fisioterapia, eletromiografia.