Improved abdomen muscle activity with interferential current therapy in cerebral palsy with constipation: a randomized controlled trial study

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ABSTRACT

Background: Children with cerebral palsy (CP) often experience many comorbidities, such as constipation. Pain and discomfort that often accompany constipation have an impact on behavior and decrease quality of life. Abdominal muscle weakness can cause a low increase in intra-abdominal pressure so that the expulsive force during defecation is not adequate.

Methods: This research is a true experimental study with pre and post-test randomized control group design. Subjects were 18 children with CP who were constipated according to the ROMA IV criteria, which were divided into two groups, namely the control group who received standard therapy (lactulose) and the intervention group who received lactulose plus IFC therapy with a frequency of 4000-4100 Hz, duration 20 minutes, 3 times a week for 1 month. The parameters evaluated in this study were the value of abdominal muscle activity at rest and during contraction. Measurements were carried out twice, before and one week after the completion of the IFC therapy session. Data were analyzed computerized with SPSS v20.0.

Results: There was a significant decrease in abdominal muscle activity at rest ($P = .024$) in the treatment group, while there was an insignificant increase in the control group ($P = .266$). The abdominal muscle activity during contraction in the treatment group showed a greater increase ($P = .730$) than in the control group ($P = .831$). The effect size in the treatment group is 0.2, which means it has a small effect, while in the control group is 0.1, which means it has no effect.

Conclusion: The addition of IFC to standard therapy (lactulose) can improve abdominal muscle activity so that IFC can be an alternative supporting therapy in cerebral palsy with constipation to provide a good clinical response.

Keywords: abdominal muscle activity, cerebral palsy, constipation, interferential current, lactulose.

INTRODUCTION

The estimated prevalence of children with CP worldwide is between 1.5 to 4 per 1000 live births, with an average of 2 per 1000 live births.1 Chronic constipation affects between 25% and 75% of children with cerebral palsy.2 Constipation is frequently overlooked in children with cerebral palsy, as it is viewed as a natural consequence of the disability and a result of other factors that are prioritized in therapy, such as seizures and postural deformities.3 The pain and discomfort that frequently accompany chronic constipation affect behavior and reduce the overall quality of life.3

The increasement of spasticity in cerebral palsy with age causes muscle stiffness that affects the gastrointestinal system, especially oral motor function and intestinal motility, causing constipation.4,5 Children with poor skeletal muscle tone and impaired muscle coordination around the anus can show bowel movement disorders. Feces will stay longer in the large intestine and have a hard consistency due to more water being absorbed.6 Constipation in cerebral palsy results from immobility, oropharyngeal dysfunction like difficulty in swallowing and chewing and also increased abdominal muscle tone, which contributes to slow peristalsis and, consequently, dry stools.7,8 In children with cerebral palsy, spasticity can be aggravated by abdominal pain due to muscle cramps and unsuccessful defecation leading to constipation and vice versa.9,10

The contraction of the abdominal wall muscles, namely the rectus abdominus muscle, plays a role in increasing intra-abdominal pressure along with contraction of the pelvic floor muscles, diaphragm, closure of the glottis and rectum during the expulsion of feces through the anus.11 Abdominal muscle weakness can cause a low increase in intra-abdominal pressure so that the expulsive force during defecation is not adequate.12
Lactulose is reported to be effective and safe in children with chronic constipation. However, lactulose is only temporary in relieving symptoms of constipation, and some side effects can occur. Since IFC therapy has been shown to cause diarrhea when used to treat urinary incontinence. It is assumed that IFC therapy also can be used to treat constipation. Following that, research was conducted on eight children who suffered from severe constipation. It was discovered that IFC administered for 20-30 minutes per session increased defecation in five of eight children and stopped soiling in seven of eight children, with therapeutic effects lasting more than three months in some children. Next study, IFC was used to treat constipation in children with myelomenigocele and can improve bowel control significantly.

Interference currents can depolarize peripheral nerve fibers through the application of electrodes placed on the surface of the treated area so that they affect motor and sensory nerve fibers. Electrical stimulation may facilitate neuroplasticity and motor learning by increasing afferent input synchronized with motor and sensory information. At low frequencies produce twitch contractions, frequencies 5-20 Hz produce partial tetanic contractions, and frequencies 30-100 Hz produce tetanic contractions. The frequency used in this study is 100 Hz, so it is expected to modulate the abdominal muscles, namely the rectus abdominus muscle.

The effect of IFC on cerebral palsy is unknown. Therefore, this study examined the effect of adding IFC therapy on constipation in children with cerebral palsy.

METHODS

This research was conducted at the outpatient clinic of the Medical Rehabilitation Department, Dr. Soetomo Academic General Hospital, for 17 months, from February 2020 to July 2021. Written informed consent was obtained from all parents or guardians of the children who agreed to be research subjects. A certificate of ethical feasibility from the Health Research Ethics Committee of Dr. Soetomo Academic General Hospital, Surabaya Indonesia number 1813/KEPK/11/2020.

Participants

Children who are eligible to participate in this study are those aged 4-18 years, diagnosed with cerebral palsy with symptoms of constipation according to ROME IV criteria, who refrain from taking drugs that can cause constipation (muscle relaxants, antiemetics, antacids, antidiarrheals, antidepressants, antipsychotics, antispasmodics, analgesics, decongestants, iron supplements) for at least 72 hours prior to treatment, except those used to treat epilepsy, hypertension, and bronchodilation. The participants with congenital anatomical abnormalities of the urogenital area, including Hirschsprung’s disease, spina bifida, anorectal malformations, urethral strictures, down syndrome or hypothyroidism, gastrointestinal bleeding, intestinal perforation, ileus obstruction, inflammatory bowel disease, toxic megacolon, metal implants or pacemakers in the abdominal area, open wounds in the abdominal and thoracic region, history of surgery on the stomach, malignancy, allergy to lactulose and the electrodes used in this study would be excluded from this study.

Study Design and Treatment

The study employed an experimental design with a control and treatment group (controlled trial). The data were collected before and after treatment randomly (pre-test and post-test with open trial single-blind Randomized Controlled Trial (RCT)). While participants were aware of the treatment they received, research staff were unaware of the treatment received by each group when completing study measurements with participants. Randomization was used to assign subjects who agreed to participate in the study to the control or treatment group. Prior to initiating therapy, the researcher collected baseline data on the subject’s basic characteristics and abdominal muscle activity at rest and during contraction. Subjects got lactulose therapy as standard therapy and IFC therapy as an intervention. The lactulose preparations were carried out by the pharmacist Dr. Soetomo Academic General Hospital with the trademark LACONS in bottles, 60 mL. Lactulose was administered by the parents at a dose of 1-3 mL/kgBW/day orally, given 2x/day for six days. The IFC equipment is located at the outpatient clinic of the Medical Rehabilitation Department, Dr. Soetomo Academic General Hospital. IFC therapy (brand ENDOMED 982) with a dose of carrier frequency 4000-4100 Hz, beat frequency 100 Hz, amplitude 1-50 mA, and sweep mode was carried out by the researchers three times a week with a duration of 20 minutes, with a total of one child undergoing 12 treatments. One week after the last therapy, abdominal muscle activity at rest and during contraction was re-evaluated. The side effects of lactulose and IFC therapy were managed according to the procedures in force at Dr. Soetomo Academic General Hospital.

Outcomes

Measurements of abdominal muscle activity were made using sEMG (MYOMED 632), and 2 active electrodes were placed on the rectus abdominis muscle below the umbilicus. The results of measuring the value of abdominal muscle activity are expressed in the number of amplitudes with units of μV.

The patient was instructed to relax for 2 minutes at rest. After that, the patient was instructed to perform the Valsalva maneuver (straining) during contraction, which is to tighten the abdominal muscles for 10 seconds, followed by a relaxation period of 10 seconds, repeated up to 5 times in a row. Movement of the limbs is reported to be accompanied by concomitant contraction of the abdominal muscles. In the supine position, arms resting along the sides of the body, the patient is asked/assisted in bending the hips and knees and bending as far as possible. The head and neck are chin tucked in, and then the head is lifted toward the chest.

Statistical Analyses

The Shapiro-Wilk test was used to test the normal data distribution. The paired t-test was used to compare the outcomes before and after treatment. The significance level was p < 0.05, and the effect sizes were also presented. A commonly used
interpretation is to refer to the effect sizes as small (d = 0.2), medium (d = 0.5), and large (d = 0.8) based on benchmarks suggested by Cohen. All statistical tests were performed using SPSS software version 26.

RESULTS

All research subjects can complete the study. At the conclusion of the study, data on nine individuals from the control group and nine individuals from the treatment group were analyzed.

A normality test was performed on the basic characteristic data using the Shapiro-Wilk test before statistical analysis. The normality test results showed that all the basic characteristic data had a normal distribution except for body weight in the treatment group, followed by a homogeneity test with a parametric statistical test (independent sample t-test) (Table 1). There was no significant difference between the mean values of each initial characteristic of pre-treatment in the two groups (p > 0.05). This means the group is homogeneous.

Based on Table 2, the mean of abdominal muscle activity at rest in the treatment group was a statistically significant decrease (p=0.024) with a mean of 28.27 ± 24.70 μV before treatment and 12.77 ± 21.61 μV after treatment. In the control group, there was an increase in abdominal muscle activity at rest with a mean of 16.95 ± 22.64 μV before treatment and 18.13 ± 23.80 μV after treatment (p=0.266).

The increasement in abdominal muscle activity during contraction in the treatment group was 16.88 ± 24.89 μV before therapy and 21.20 ± 26.12 μV after therapy (p=0.730). In the control group, the increasement of abdominal muscle activity during contraction was 9.53±5.1 μV before therapy and 9.97±5.7 μV after therapy (p=0.831).

DISCUSSION

Abdominal muscle activity at rest before therapy was shown above the baseline value with an average of 28.27±24.70 μV in the treatment group and 16.95±22.64 in the control group. A complete noise-free recording is impossible: small amplitude spikes or random nature may be visible, but they should not exceed 10 – 15 microvolts.26 The average noise level is good, in the range of 1 to 3.5 microvolts.26

The results of this research indicate that abdominal muscle activity is indeed high before IFC therapy. Other studies using EMG found that there was an increase in abdominal muscle activity both at rest and during contractions in children with spastic cerebral palsy compared to normal children in their age, between 7 to 16 years.27 A significant increase in abdominal muscle activity at rest in individuals with spastic cerebral palsy indicates the occurrence of hypertonia.27,28 These measurements recorded during the resting phase could be due to increased motor neuron activity and uninhibited activity of motor neurons in this muscle.27

In this study, it was found that there was a significant decrease in abdominal muscle activity at rest after IFC therapy in the treatment group (p=0.024). Similar to this study, a significant decrease in gastrocnemius muscle tone in chronic stroke patients has been shown as measured by the MyotonPRO device after being given IFC therapy with a carrier frequency of 4000-4100 Hz, beat frequency of 100 Hz for 30 minutes.29 In a previous study, giving IFC for 60 minutes after exercise therapy resulted in a direct decrease in gastrocnemius muscle spasticity scores.30 The 100 Hz electrical stimulation can isolate gamma-aminobutyric acid from the dorsal horn of the spinal cord.31 Electrical stimulation appears to decrease muscle tone by increasing presynaptic inhibition.32 The MAS score decreased by 41% after IFC therapy, which means that IFC therapy is more effective in reducing spasticity than TENS (according to previous studies, TENS reduced spasticity by 9-30%).33 They further reported that the IFC generates a 100 Hz interference wave between two medium frequency currents across the skin surface which is associated with less skin resistance so that the IFC can penetrate deep tissue effectively and stimulate muscles directly, thereby further reducing tone.34 Inhibitory neurotransmitters such as GABA and opioid agonists can exert anti-spastic effects by inducing inhibitory neurotransmitters at presynaptic terminals.33 High-frequency electrical stimulation (100Hz) results in the release of inhibitory neurotransmitters in the

**Table 1.** Normality and homogeneity test of the characteristics of research subjects in pre-treatment for both groups.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Treatment (n = 9)</th>
<th>p-value</th>
<th>Control (n = 9)</th>
<th>p-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Means ± SD</td>
<td></td>
<td>Means ± SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (year)</td>
<td>7.89 ± 3.23</td>
<td>0.091</td>
<td>5.78 ± 1.39</td>
<td>0.348</td>
<td>0.091</td>
</tr>
<tr>
<td>Sex (L/P)</td>
<td>4L:5P</td>
<td></td>
<td>7L: 2P</td>
<td></td>
<td>0.165</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>16.61 ± 7.70</td>
<td>0.001</td>
<td>17.44 ± 6.89</td>
<td>0.449</td>
<td>0.812</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>107.78 ± 16.78</td>
<td>0.166</td>
<td>100.22 ± 14.91</td>
<td>0.655</td>
<td>0.328</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>13.88 ± 2.50</td>
<td>0.492</td>
<td>16.86 ± 3.53</td>
<td>0.120</td>
<td>0.056</td>
</tr>
</tbody>
</table>

**Table 2.** Abdominal muscle activity (Pre and Post-treatment for both groups).

<table>
<thead>
<tr>
<th></th>
<th>Treatment (n=9)</th>
<th>Control (n=9)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Abdominal muscle activity at rest (μV)</td>
<td>28.27±24.70</td>
<td>12.77±21.61</td>
</tr>
<tr>
<td>Increase abdominal muscle activity during contraction (μV)</td>
<td>16.88±24.89</td>
<td>21.20±26.12</td>
</tr>
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*Significant if p-value < 0.05
spinal cord. Interventions that produce a resultant beat frequency of 100 Hz into the tissue are expected to increase levels of endogenous inhibitory neurotransmitters and can cause effects similar to anti-spastic drugs. Several previous studies have shown that increased abdominal muscle tone is associated with slow intestinal peristalsis, which can lead to constipation. A case that gave massage to the spastic abdominal muscle for 15 to 20 minutes daily to relieve constipation in a 21-year-old man with cerebral palsy. The authors stated that the cause of constipation in the patient was severe abdominal muscle spasticity. The patient managed to defecate spontaneously within half an hour after the massage without the need for enemas. The authors concluded that abdominal muscle massage was effective in reducing abdominal muscle spasticity, thereby helping intestinal peristalsis.

Assessment of strength seen from the abdominal muscle activity increase during contraction from rest. There was an insignificant increase in abdominal muscle contraction (p=0.730) with a mean of 16.88 + 24.89 before therapy and 21.20 + 26.12 after therapy in the treatment group. In the control group, there was an insignificant increase (p=0.831) with a mean of 9.53 + 5.1 before therapy and 9.97 + 5.7 after therapy. The result of the effect size in the treatment group is 0.2, which indicates that therapy in this group has a small effect, while the effect size result in the control group is 0.1, which indicates that therapy in this group has no effect on increasing the activity (strength) of the abdominal muscles. This is consistent with the results of a study by Rajan et al., who gave IFC therapy with a beat frequency of 50 Hz, a sweep of 50 Hz for 10 minutes in quadriiceps muscles postoperative of lower extremity fractures (14 patients per group) and assessed the increase in quadriiceps isometric muscle strength using a sphygmomanometer. Although not statistically significant, this study found that IFC therapy was better than a conventional exercise in reducing pain and increasing muscle strength in the short-term effect after 6 days of therapy, but the conventional exercise was more able to maintain the anti-pain effect and increase muscle strength for a longer duration (2 weeks after the last therapy).

Research on patients with stress urinary incontinence obtained significantly better results in terms of abdominal muscle strength as measured by a sphygmomanometer, pelvic floor muscle strength as measured by the Oxford scale, and urinary incontinence questionnaire in the treatment group (25 subjects) who were given Kegel exercises, transverse abdominis strengthening plus IFC therapy than the control group (25 subjects) who were only given Kegel exercises and transverse abdominis strengthening, five days/week for 4 weeks. IFC therapy was given on the lower abdomen just above the outside of the inguinal ligament and the other two on the inside of the thigh close to the origin of the adductor muscle with an intensity of 0-90mA, frequency of channel I 4000-4250Hz, channel II constant 4000Hz, base 0-100Hz, spectrum 0-150Hz, duration 20 minutes. IFC therapy has the advantage of deeper stimulation and more comfortable felt by the subject when the pelvic floor muscles are stimulated. In addition to the direct motor response, this reflex stimulus causes widespread contraction that can strengthen the pelvic floor muscles, elevate the bladder neck and increase outflow resistance to urine leakage.

The limitation of this study is the Interferential Current (IFC) therapy intervention is carried out together with standard therapy (lactulose) so that the benefits of Interferential Current (IFC) therapy cannot be assessed alone.

CONCLUSION
This study indicates that the addition of IFC to standard therapy (lactulose) can improve abdominal muscle activity so that IFC can be an alternative supporting therapy in cerebral palsy with constipation to provide a good clinical response.

ETHICAL CLEARANCE
This research has already got a certificate of ethical feasibility from the Health Research Ethics Committee of Dr. Soetomo Academic General Hospital, Surabaya Indonesia number 1813/KEPK/11/2020.

FUNDING
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CONFLICT OF INTEREST
The author reports no conflicts of interest in this work.

AUTHOR CONTRIBUTION
All authors have contributed equally from the conceptual framework, data acquisition, and data analysis until the study results are reported through publication.

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REFERENCES


