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Research Article

The Effect of Laser Acupuncture on Spasticity in Children with Spastic Cerebral Palsy

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ABSTRACT

Background: Spasticity in cerebral palsy is one of the most common disabilities of children in developing countries.
Objectives: The objective of this study was to determine the efficacy of laser acupuncture on spasticity in children with spastic cerebral palsy.
Methods: This clinical trial was conducted on 60 patients with spastic cerebral palsy at 2 to 10 years. The patients were categorized into two groups: the control group and treatment group. Laser acupuncture was applied on GV20, GV14, LI4, GB34, and LR3 (power 50 mW, 785 nm, 1 Joule, 40 seconds) three times a week for 12 sessions in the treatment group and placebo laser acupuncture on the same points in the control group. The spasticity was measured using the Modified Ashworth Scale before and after complete sessions.
Results: The results showed that there was a significant reduction in the Modified Ashworth Scale score in the treatment group compared with the control group ($p = 0.003$).
Conclusions: This study suggest that laser acupuncture on GV20, GV14, LI4, GB34, and LR3 can reduce spasticity for children with spastic cerebral palsy.

1. Introduction

Cerebral palsy is a group of permanent motor development disorder and body posture that causes limited activity [1,2]. The condition is correlated to damage or lesion of the central nervous system during the prenatal, perinatal, and postnatal period when the central nervous system has not been well developed [3]. Cerebral palsy is the main cause of spasticity in children with the percentage reaches 80% [4]. The prevalence of children with cerebral palsy was 2.11 per 1000 live births [5]. In Indonesia, it is estimated as many as 1 to 5 per 1000 live births [6]. Spasticity that has occurred for a long period of time causes changes in anatomical structures such as bone subluxation or dislocation, joint contractures, or muscle changes into fibrotic tissue. Spasticity causes problems on longitudinal growth of muscle and length of muscle fibers, reduced muscle volume, altered motor unit size, and changes in types of muscle fibers and neuromotor junction [7].

Conventional therapy for spastic cerebral palsy has been concentrated to increase the function and minimize complications [8,9]. Acupuncture is a medical procedure, an effective non-pharmacological therapy and provides promising results for some pediatric problems [10,11]. Laser acupuncture is one of the acupuncture techniques with minimal side effects and safe for children. Stimulation of acupuncture points using low intensity laser light can induce photobiostimulation reaction on cells and tissues [12,13]. Laser acupuncture does not cause mechanical effect resembling the manual acupuncture; however, it has similar mechanism in stimulating the signal transduction pathway [14]. There are many hypotheses explaining spasticity, one of those that has been believed is changes of balance between excitatory and inhibitory inputs of motor neuron groups [15]. Acupuncture studies have demonstrated the beneficial effects of laser acupuncture for reducing spasticity in children with spastic cerebral palsy, including biochemical changes in cellular and tissue level [12–14,16,17],

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hemodynamic changes during stimulation [18], affecting brain neurotransmitter [19–21] and autonomic nervous system [22, 23]. The aim of this study is to determine the effects of laser acupuncture at GV20 Baihui, GV14 Dazhui, LI4 Hegu, GB 34 Yanglingquan, and LR3 Taichong points on reducing Modified Ashworth Scale (MAS) scores in children with spastic cerebral palsy.

2. Material and methods

The single-blinded, randomized clinical trial was conducted from July to December 2017 at the outpatient clinic of Acupuncture and Pediatric Medical Rehabilitation Cipto Mangunkusumo National Hospital, Jakarta, Indonesia. The inclusion criteria included patients who aged between 2 and 10 years, who had a diagnosis of spastic cerebral palsy by a pediatrician, with at least one spastic muscle in the extremities, whose parents/guardians signed the informed consent form, and who were willing to complete the study. The exclusion criteria were patients with anatomical disorder, poor nutritional status, severe gastroesophageal reflux disease, patients with contraindications for laser acupuncture, and those who did not agree to participate in the study. When the patients had two consecutive absences, they would be considered as dropouts and they could not continue the treatment. Of the total 60 patients, 8 patients were dropouts, and 52 patients were randomly selected into two groups, the treatment group that received laser acupuncture and the control group receiving placebo laser acupuncture. There were 26 patients in each group, and all patients received the same routine treatment 3 times a week for 12 sessions. All assessments were performed by the same investigator using the MAS [24] before and after completing all treatment sessions. The following muscles were examined: *m. biceps brachii*, *m. brachioradialis*, *m. pronator teres*, *m. flexor digitorum*, *m. flexor pollicis, m. hamstring*, *m. illiopsoas*, *m. adduktor, m. quadriceps femoris, m. gastrocnemius*, and *m. tibialis posterior.*

The instrument used was LaserPen Practice, RJ Low level Laser class 3B, Nogier C acupuncture frequencies from RJ-Laser Germany™ with a maximum power of 50 mW, 785 nm, Nogier C frequencies, and an applicator of 4 mm in diameter. The treatment group received laser acupuncture at GV20, GV14 [16], LI4 [4], GB34, and LR3 [4] points (see Fig. 1) for 1 Joule and 40 seconds of treatment time at each point. The laser pen was turned on, and when the laser was activated, we could see the red light at the end of applicator. The control group received placebo laser acupuncture without activated laser light.

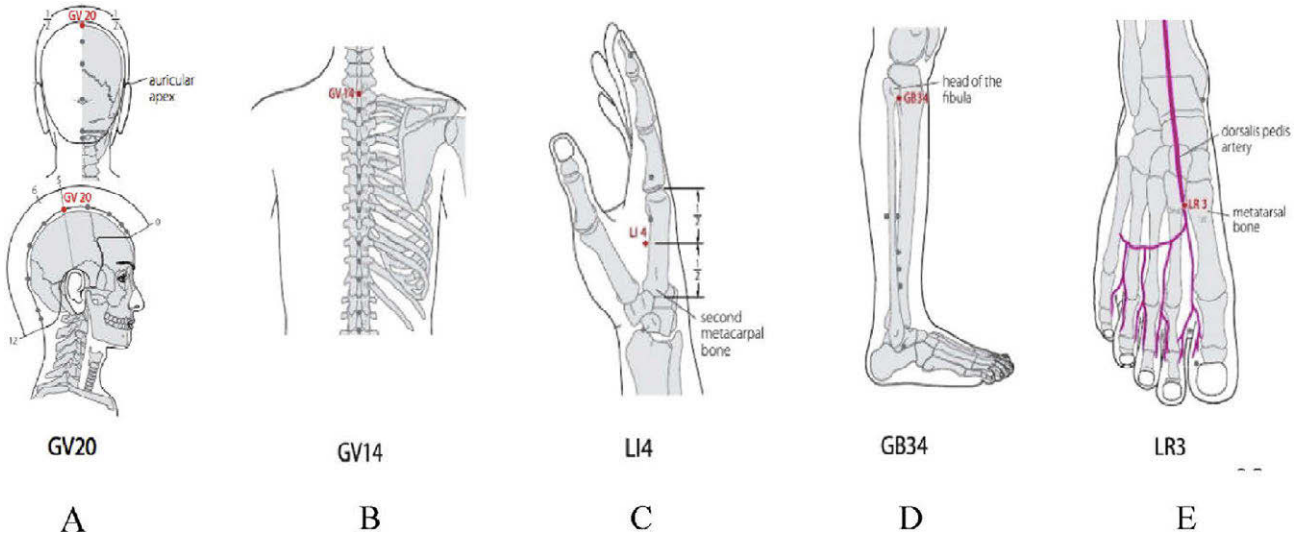

Figure 1. Location of acupuncture points based on the World Health Organization standart acupuncture points locations in the Western Pacific Region. 2008. A. GV20 Baihui. B. GV14 Dazhui. C. LI4 Hegu. D. GB34 Yanglingquan. E. LR3 Taichong.

Table 1
Subject characteristics.

Characteristics	Treatment group (n = 26)	Control group (n = 26)	Total	*p*
Age (years)				
Median (min.–max.)	4.50 (2–10)	6.00 (3-10)	52 (2-10)	0.060[a]
Gender				
Male, n (%)	14 (53.8)	12 (46.2)	26 (50.0)	0.579[b]
Female, n (%)	12 (46.2)	14 (53.8)	26 (50.0)	
Diagnosis				
Spastic diplegia CP, n (%)	5 (19.2)	7 (26.9)	12 (23.1)	0.305[b]
Spastic hemiplegia CP, n (%)	2 (7.7)	5 (19.2)	7 (13.5)	
Spastic quadriplegia CP, n (%)	19 (73.1)	14 (53.8)	33 (63.5)	
Pelvic X-ray				
Normal	6 (23.1)	7 (26.9)	13 (25.0)	0.675[b]
Not yet on X-ray	4 (15.4)	6 (23.1)	10 (19.2)	
Subluxation	16 (61.5)	13 (50.0)	29 (55.8)	
MAS before, n (mean)	26 (70.88)	26 (61.81)	52 (66.34)	0.056[a]

MAS = Modified Ashworth Scale.
[a] Unpaired t test.
[b] Chi-square test.

Table 2
Delta mean difference of total MAS score after treatment between the group receiving laser acupuncture and the control group.

Variable	Mean (SD)	Mean difference (95% CI)	*p*
Δ before and after			
Laser acupuncture	6.00 (10.740)	8.923 (2.616 – 15.230)	0.003[a]
Placebo laser acupuncture	−2.231 (11.874)		

Δ = delta; SD = standard deviation; CI = confidence interval; MAS = Modified Ashworth Scale. There was statistically significant difference of total MAS scores between the treatment group and the control group ($p = 0{,}003$)
[a] Unpaired t test.

Table 3
The mean difference of the total MAS score after receiving treatment between the laser acupuncture group and control group.

Variable	Before mean (SD)	After mean (SD)	Mean difference (95% CI)	r	*p*
Laser acupuncture	70.88 (15.10)	64.19 (18.51)	6.692 (2.354-11.030)	0.815	0.002[a]
Placebo laser acupuncture	61.81 (18.22)	64.04 (19.23)	−2.231 (−7.027-2.565)	0.800	0.174[a]

r = correlation; SD = standard deviation; CI = confidence interval.
[a] Paired t test.

2.1. Ethical

At the beginning of the study, researchers provided verbal explanation about the objective and methods, and then, all parents or guardians of participants signed written informed consent forms. The confidentiality was guaranteed between the patients and the researchers. This study was approved by the Ethics Committee of the Faculty of Medicine, University of Indonesia (No. 664/UN2.F1/ETIK/2017).

2.2. Statistical analysis

Data were analyzed by statistic tests using the SPSS (IBM SPSS Statistics 20.0) computer software program for Windows, version 20.0 (SPSS Inc., USA). All of numeric data were tested using the Saphiro–Wilk Test. The statistic test used for numeric data with normal distribution was unpaired t test, whereas when the data distribution was not normal, the Mann–Whitney U test was used. The significance limit of 0.05 was used along with 95% confidence interval (CI). When the *p* value < α ($p < 0.05$), it was considered as statistically significant.

3. Results

According to the results obtained, the median of age for patients in the treatment group was 4.5 years and the control group was 6 years. Most of the patients were men (53.8%) in the treatment group and women (53.8%) in the control group. More than half of the patients were spastic quadriplegia cerebral palsy (63.5%) with pelvic subluxation (55.8%). The mean ratio of MAS scores before treatment in the treatment group was 70.88, while in the control group, it was 61.81. No significant differences were observed between the treatment and control groups in terms of subjects characteristic (Table 1).

After the patients received treatment, the delta mean difference of the total MAS scores was 8.923 with $p = 0.003$ ($p < 0.05$) and the 95% CI was between 2.616 and 15.230. There was statistically significant difference of total MAS scores between the treatment group and the control group (Table 2).

In the treatment group, there was a statistically significant difference on the mean of reduced MAS scores after the patients received all sessions (95% CI = 2.354 – 11.030; $p = 0.002$), whereas in the control group, there was no statistically significant difference after the patients received all sessions (95% CI = −7.027 – 2.565; $p = 0.174$) (Table 3).

From both groups, the total of 28 patients with reduction of MAS scores and 24 patients without any reduction, $p = 0.0260$ ($p < 0.05$) and an OR = 3.6, which means that the laser acupuncture caused reduction of MAS scores 3.6 greater compared to the placebo laser acupuncture (Table 4). The muscles with the greatest reduction of MAS scores were *m. adductor* $p = 0.017$ ($p < 0.05$), *m. gastrocnemius* $p = 0.030$ ($p < 0.05$), and *m. illiopsoas* $p = 0.035$ ($p < 0.05$) (Table 5).

4. Discussion

Laser acupuncture treatment has been selected in this study because the modality of treatment is safe for children and has the following benefits: does not cause any pain, can be easily performed, has a short duration of treatment, has noninvasive characteristic, and almost does not have any side effect if it is performed correctly. Results of this study are similar to results of a study conducted by Dabbous et al [4], where laser acupuncture was used an adjunctive therapy for spastic cerebral palsy in children, and the study by Anwar and Khan [25]; where cerebral palsy was treated with aculaser therapy.

Stimulating acupuncture points affects activities of the brain area processing motor signal and causes changes of activities in the areas associated with motor function (motor-related area) and sensorimotor area and also affects corticocerebellar connection. Moreover, the photobiomodulation effect of laser acupuncture may affect the autonomic nervous system by inhibiting sympathetic nerve fibers and increasing

Table 4
The number of participants experiencing improvement after receiving treatment in the laser acupuncture group and control group.

Group	Qualitative assessment			OR	
	Improvement	No improvement	Total	(95% CI)	*p*
Laser acupuncture	18	8	26	3.6 (0.050-0.059)	0.026[a]
Placebo laser acupuncture	10	16	26		
Total	28	24	52		

OR = odds ratio; CI = confidence interval.
[a] Chi-square test.

Table 5
The improved muscles after receiving treatment in the laser acupuncture group and control group.

Muscles	Group		OR	95% CI	*p*
	Laser acupuncture	Placebo laser acupuncture			
Biceps brachii					
Improvement	10	9	0.14	0.090–0.102	0.030
No improvement	8	1			
Brachioradialis					
Improvement	11	8	0.39	0.402–0.421	0.152
No improvement	7	2			
Pronator teres					
Improvement	18	10	0	-	-
No improvement	0	0			
Flexor digitorum					
Improvement	18	10	0	-	-
No improvement	0	0			
Flexor pollicis					
Improvement	8	3	1.87	0.679–0.697	0.226
No improvement	10	7			
Illiopsoas					
Improvement	10	2	5	0.104–0.117	0.035[a]
No improvement	8	8			
Adduktor					
Improvement	9	1	9	0.041–0.049	0.017[a]
No improvement	9	9			
Hamstring					
Improvement	6	1	4.58	0.353–0.372	0.172
No improvement	12	9			
Gastrocnemius					
Improvement	8	1	7.2	0.090-0.101	0.061[a]
No improvement	10	9			
Tibialis posterior					
Improvement	9	3	2,3	0.424–0.443	0.153
no improvement	9	7			

OR = odds ratio; CI = confidence interval.
[a] Chi-square test.

parasympathetic activity, stimulating release of vasodilators such as P substance, calcitonin gene-related peptide, and nitric oxide resulting in improved circulation, and reducing muscle tone through the produced neurotransmitters [26] by segmental mechanism of the spinal cord and supraspinal structure, which includes the cerebral cortex, limbic system, basal ganglia, and brain stem with neurotransmitters such as endorphin, gamma aminobutyric acid (GABA), serotonin, acetylcholine, and other neuropeptides; moreover, laser acupuncture affects motor neuron activity, particularly the α-motor neuron [27]. Increased inhibitory function and suppressed excitability of α-motor neuron as a result of increased amount of GABA neurotransmitter, which acts as the main inhibitory neurotransmitter, could cause reduced muscle tone and alleviate spasticity [28]. The neuroprotective function of laser acupuncture has some roles in preventing the development of further neuron damage; one of those roles is by increasing the production of neurotropic factors such as brain-derived neurotrophic factor, glial cell line–derived neurotrophic factor, nerve growth factor, and basic fibroblast growth factor. It also increases the activity of antioxidant enzymes such as superoxide dismutase and glutathione peroxidase [29]. This study has demonstrated that the greatest reduction of the MAS score is found for *m. adductor*, *m. gastrocnemius*, and *m. illiopsoas.*

5. Conclusion

In conclusion, the stimulation of laser acupuncture on GV20, GV14, LI4, GB34, and LR3 can reduce spasticity for children with spastic cerebral palsy. Further investigation with a longer study period is needed to show the mechanism of the effect of laser acupuncture and to determine the period of optimal treatment.

Declaration of competing interest

There was no conflict interest.

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