Effect of Laser Stimulation of Acupoint Taichong (LR3) on Blood Pressure and Heart Rate Variability

M Tsai, Y Wang

Citation

M Tsai, Y Wang. *Effect of Laser Stimulation of Acupoint Taichong (LR3) on Blood Pressure and Heart Rate Variability*. The Internet Journal of Alternative Medicine. 2014 Volume 9 Number 1.

Abstract

This study investigated the real-time effects of laser acupoint stimulation of the acupuncture point Taichong (LR3), on blood pressure and heart rate. Eighteen subjects were included in this single-blind, repeated-measures study. All subjects received sham (placebo) and active laser treatment in sequence. The sham laser treatment was conducted identically to the active laser treatment, but without any power supplied to the laser. The acupuncture point used in this study was LR3 (Taichong). For blood pressure, the active treatment was administered for a total of 7 min. Systolic blood pressure, diastolic blood pressure, and heart beats per minute were reduced significantly by 15 mmHg, 11.5 mmHg, and 5 beats/min, respectively after the active treatment. There were no significant differences in these parameters after the placebo treatment. With regard to heart rate variability, normalized low frequency (nLF) before-during, during-after, and before-after the active treatment were reduced by 3.19 ± 3.06, 6.67 ± 3.35, and 9.86 ± 2.05, respectively. The nHF were reduced by -3.19 ± 3.06, -6.67 ± 3.35, -9.86 ± 2.05, respectively. The low-frequency/high-frequency ratios (LF/HFs) were reduced by 0.82 ± 5.05, 0.68 ± 0.35, and 1.5 ± 0.38, respectively, after the active treatment. The only significant change was before-after treatment. There were no significant changes after the placebo treatment. It was concluded that low-level laser treatment of the acupoint resulted in “real time” lowered blood pressure, via stimulation of LR3. A significant difference was observed in heart rate variability after the laser acupoint treatment.

INTRODUCTION

The ministry of health has reported that hypertension is responsible for one tenth of all deaths (Health and Welfare Department of the Ministry of National Health, 2013). Hypertension is a risk factor for cardiovascular and cerebrovascular disease. Regular control of blood pressure can reduce morbidity caused by stroke or myocardial infarction by 40% and 15% respectively (Essential Medicines and Health Products Information Portal, 2003). Up to 32.3 billion dollars was spent on hypertension, hyperlipidemia, and diabetes medication in the year 2008, accounting for a quarter of total national health insurance expenditure. Therefore, prevention of hypertension is a good index of health (Chobanian et al. 2003). The scientific assessment of acupoint stimulation may lead to greater success in controlling this silent killer, and to minimization of the side effects of some medications (Chang et al., 2008; Hung et al., 2004; Huand and Zhang, 2009; Macklin et al., 2006).

Acupuncture therapy for hypertension has been approved by the World Health Organization (Essential Medicines and Health Products Information Portal, 2003). The relevant research found that Taichong acupoint (LR3) stimulation was effective in the reduction of hypertension (Huan-lin et al, 2008). With regard to physiological changes, acupoint stimulation also has a sedative effect as measured by electroencephalogram, and reduces heart rate variability (Hsu et al., 2007). On the other hand, there are only a few reports of the use of laser light acupoint treatment as hypertension therapy (Odud and Potapenko, 1991; Sobetskii, 2003; Zhang et al., 2008).

The response of the autonomic nervous system can be monitored using heart rate variability (HRV). Imbalance of the autonomic nervous system is involved in the development of hypertension (Hsu et al., 2007; Pavithran et al., 2008). HRV is a noninvasive tool to quantitatively estimate cardiac autonomic activity, and it has been used to document reduced cardiac autonomic activity in hypertension (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996; Schroeder et al. 2003). High frequency (HF) is considered to represent vagal control of heart rate. Low frequency (LF) is contributed to by both vagal, and sympathetic nerves. The ratio of LF/HF is considered to reflect sympathetic modulations (Health and Welfare Department of the Ministry of National Health, 2013).

Low-level laser light replacement of traditional needles in acupoint therapy is referred to as laser acupuncture. Its benefits include painlessness, aseptic nature, no mechanical injury, and that it promotes a healthy body. It has a biochemical effect as well as therapeutic effects on local tissue, the nervous system, circulatory system, and the immune system (Sobetskii, 2003; Weber et al., 2007). There is evidence of nitrous oxide (NO) involvement in the responses to laser acupuncture therapy, including an increase in inducible nitric oxide synthase production after exposure to low-level laser light (Mester et al., 1985; Moriyama et al., 2005). Research has shown that functional magnetic resonance imaging has the potential to elucidate the effects of laser acupuncture on brain activity (Siedentopf et al., 2002). The suggested clinical treatment dose for low-level laser treatment is 8–10 J/cm2 (Mester et al., 1985). Low-level laser radiation was found to have a stimulatory effect on cells, and high-level radiation had an inhibitory effect (Weber et al., 2007). The device emits light at a wavelength of 808 nm, with an output power of 20 mW, resulting in a treatment dose of 8.4 J/cm2. There have been some studies in this area, and HRV may change during needle acupuncture (Haker et al., 2000; Li et al., 2005). The influence of laser acupuncture on changes in HRV has been little studied (Odud and Potapenko, 1991; Sobetskii, 2003; Hubscher et al., 2007).

We selected Taichong (LR-3) because it is important in traditional Chinese medicine, and it is the most commonly used acupoint for various conditions including hypertension, glucose control, insomnia, and obesity (Huan-lin et al., 2008). The specific aims of the study were to test the effectiveness of laser acupuncture stimulation of a specific acupuncture point on blood pressure. We also examined the change in HRV before, during, and after treatment. All subjects were subjected to both placebo treatment, and active treatment.

The hypothesis was that the stimulation of a pattern of acupoints with laser acupuncture would reduce plasma endothelin (ET) and nitric oxide (NO) balance, reduce blood pressure, and may regulate the sympathetic–parasympathetic system.

MATERIALS AND METHODS

Subjects

Eighteen subjects were included in the study, and all underwent blood pressure screening. All subjects provided written informed consent before participating in the study.

Inclusion criteria

Men and women with systolic blood pressure from 100–200 mmHg and diastolic blood pressure from 70–120 mmHg, aged from 20–45 years, and naive to low-level laser therapy were enrolled in the study.

Exclusion criteria

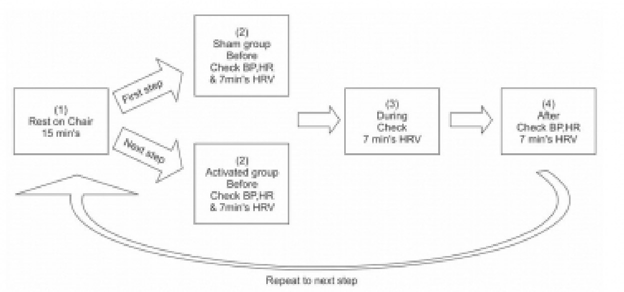
Individuals with systemic chronic disease or illness, skin or bleeding disorders, and those currently taking drugs or medications were excluded from the study.

Study design

This was a single-blind, repeated-measures study, and all subjects were administered both the placebo treatment and the active treatment. The experimental procedure is shown in Figure 1. Blood pressure, heart rate, and HRV before treatment were measured after subjects had rested on a chair for 15 minutes. Parameters of HRV included nLF, nHF, and LF/HF. The subjects were then administered sham low-level laser treatment with no power output to the laser for 7 min, applied to the LR3 (Taichong) acupoint, as the placebo treatment. HRV was recorded during the sham treatment. After sham treatment, blood pressure, heart rate, and 7 min of HRV were recorded. All subjects subsequently rested for 15 min, then received 7 min of activated laser treatment. The subjects were blinded as to which was the sham laser treatment and which was the activated laser treatment. Blood pressure and heart rate data were collected before and after treatments. For HRV, data was collected before, during, and after treatment.

Figure 1

Protocol used in this study



Step 1 is sham laser phase. Step 2 is activated laser phase.
Box 1 shows the resting phase when the subject rests on chair for 15 minutes.
Box 2 shows the step before laser treatment. Blood pressure, heart rate and 7 minutes of HRV are recorded
Box 3 shows the step during laser treatment. 7 minutes of HRV is recorded.
Box 4 shows the step after laser treatment. Blood pressure, heart rate & 7 minutes of HRV are recorded.

Instrumentation

Blood pressure: A Rossmax wrist circumference blood pressure monitor was used to measure blood pressure. Blood pressure measurements were taken in a sitting position after a 15-min rest, and after both the sham treatment, and the activate treatment.

The apparatus used was the LA-400 "United Integrated Services" Multi-Channel Laser Therapy System, FDA (510K):K082686.

HRV: A TD1A was used to acquire the HRV data, with digital signal processing software.

Statistical analysis

We examined differences in systolic blood pressure, diastolic blood pressure, and heart rate, between pre- and post-laser acupuncture sessions, using the paired t-test. Between treatment, comparisons were also assessed using the paired t-test. Repeated measures ANOVA was used to assess the differences in HRV changes before, during, and after treatment. All statistical analyses were conducted using SPSS software. A p value of <0.05 was considered statistically significant.

RESULTS

The baseline data for all subjects are shown in Table 1. Height, age, systolic blood pressure, and diastolic blood pressure were all normally distributed (p > 0.05), while weight was not normally distributed (p < 0.05). All subjects completed the study.

Table 1

Sex	N=18	skewness	kurtosis	p value
Male	11(61.1%)	—	—	
Women	7 (38.9)	—	—	
Age (y/o)	32.61±6.23	0.58	-0.92	>0.05
Height(m)	169.83±8.9	-0.12	-1.56	>0.05
Body weight(Kg)	81.00±19.7	-0.61	-0.68	<0.05
SBP (mmHg)	139.56	± 22.20	0.396	0.225
DBP (mmHg)	89.67	± 16.05	0.221	0.24
HR (beats/mins)	75.89	± 11.54	0.566	-0.369

SBP:systolic blood pressure
DBP:diastalic blood pressure
HR:heart rate
Data are expressed as means ± standard deviation

Blood pressure

The within group blood pressure comparisons before and after treatment are shown in Table 2, and the comparisons between the two groups (placebo and treatments) for blood pressure are shown in Table 3.

Table 2

Paired t-test results of within placebo group and within active treatment group comparisons

	Placebo			Treatment		
Items	before	after	p value	before	after	p value
SBP (mmHg)	137.11 ± 22.11	135.61 ± 20.64	0.41	142 ± 22.66	126.17 ± 14.44	< 0.005**
DBP (mmHg)	87.06 ± 15.91	86.06 ± 13.82	0.55	92.28 ± 16.22	80.78 ± 11.51	< 0.005**
HR (beats/mins)	73.5 ± 2.48	73.56 ± 2.88	0.98	78.28 ± 12.31	72.5 ± 12.36	< 0.013**

** Statistically significant difference
Data are expressed as means ± standard deviation

Table 3

Paired t-test results of between placebo and active treatment comparisons

(*n* = 18)	Placebo	Active (*n* = 18)	*p* value
Mean systolic pressure (mmHg)	136.4 ± 5	134 ± 1	0.001**
Mean diastolic pressure (mmHg)	83.4 ± 3	89.7 ± 3	0.001**
Mean heart rate (beats/min)	73 ± 2.7	75 ± 2.5	0.038*
Mean nLF (n.u)	71.4 ± 3.5	66.8 ± 3.7	0.01*
Mean nHF (n.u)	28.6 ± 3.5	33.2 ± 3.7	0.02*
Mean LF/HF	3.85 ± 0.6	2.99 ± 0.5	0.04*

Data are expressed as means ± standard deviation
** Statistically significant difference
* Statistically difference

There were no significant differences before and after the sham laser treatment. After the activated laser treatment sessions, both systolic, and diastolic blood pressure decreased significantly. The mean systolic blood pressure was 142 ± 22 mmHg before the treatment, and it was 126 ± 14 mmHg ($p < 0.005$) after treatment. The mean diastolic blood pressure was 92 ± 16 mmHg before treatment, and it was 80 ± 11 mmHg ($p < 0.005$) after the treatment. There were significant differences in comparisons between the two treatments. Mean systolic blood pressure of placebo was 136.4 ± 5, and mean systolic blood pressure of the active treatment was 134 ± 1, $p < 0.001$.

Heart rate

Comparisons between the two treatments for heart rate and before and after treatment within each group (treatment) are shown in Table 2 and Table 3. There were no significant differences before and after the sham laser treatment, while heart rate decreased in the active treatment group. Before the active treatment the mean heart rate was 78 ± 12, and after the active treatment it was 72 ± 12 ($p < 0.013$). There were significant differences in comparisons between the sham and the active treatments. Mean heart rate of placebo was 73 ± 2.7, mean heart rate of the active treatment was 75 ± 2.5 ($p = 0.038$).

Heart rate variability

Comparisons between the two treatments for HRV are shown in Table 3. Mean nLFs of the placebo and active treatments were 71.4 ± 3.5 and 66.8 ± 3.7 respectively, and this difference was statistically significant ($p = 0.01$). Mean nHFs of the placebo and activated treatments were 28.6 ± 3.5 and 33.2 ± 3.7 respectively, and this difference was statistically significant ($p = 0.02$). Mean LF/HFs of the placebo and activated treatments were 3.85 ± 0.6 and 2.99 ± 0.5 respectively, representing a statistically significant difference ($p = 0.04$).

The comparisons before, during, and after sham laser treatment are shown in Table 4. There were no significant differences in HRV before, during, and after sham laser treatment.

The comparisons before, during, and after activated laser treatment are shown in Table 4.

Table 4

Repeated measures ANOVA test of HRV

	Placebo			Treatment		
	nLF (n.u)	nHF (n.u)	LF/HF	nLF (n.u)	nHF (n.u)	LF/HF
Before (a)	68.17 ± 20.74	31.83 ± 4.88	3.68 ± 2.98	71.39 ± 16.38	28.86 ± 16.38	3.76 ± 3.11
During (b)	73.84 ± 12.9	26.16 ± 3.05	3.93 ± 2.72	67.95 ± 16.75	32.05 ± 16.75	2.94 ± 2
After (c)	72.16 ± 15.5	27.84 ± 3.66	3.94 ± 2.92	61.28 ± 18.35	38.72 ± 18.35	2.26 ± 1.74
p value (a)-(b)	0.12	0.12	0.46	0.312	0.312	0.122
p value (b)-(c)	0.56	0.56	0.98	0.062	0.062	0.071
p value (a)-(c)	0.26	0.28	0.54	<0.001**	<0.001**	<0.001**

** Statistically significant difference
Data are expressed as means ± standard deviation

The parameters compared with regard to HRV included nLF, nHF, and LF/HF. The mean nLFs before, during, and after active laser treatment were 71.39 ± 16.38 n.u, 67.95 ± 16.75 n.u, and 61.28 ± 18.35 n.u respectively (Table 4). There were no statistically significant differences in before-during treatment, or during-after treatment ($p = 0.312$ and $p = 0.062$ respectively, Table 4). For the before-after activated treatment comparison, the difference was statistically significant ($p < 0.001$, Table 4). The mean nHFs before, during, and after active laser treatment were 28.86 ± 16.38, 32.05 ± 16.75, and 38.72 ± 18.35 respectively (Table 5). There were no statistically significant differences in the before-during treatment, or the during-after treatment comparisons ($p = 0.312$ and $p = 0.062$ respectively, Table 7). There was a significant difference in the before-after activated treatment comparison ($p < 0.001$, Table 4).The mean LF/HFs before, during, and after active laser treatment were 3.76 ± 3.11, 2.94 ± 2.00, and 2.26 ± 1.74 respectively (Table 4). There were no statistically significant differences in the before-during treatment or during-after treatment comparisons ($p = 0.122$ and $p = 0.071$ respectively, Table 4). There was a statistically significant difference in the before-after activated treatment comparison ($p = 0.001$, Table 4). It was concluded that mean HRV after the placebo treatment differed from that after active treatment.

DISCUSSION

Many studies have applied low level laser light to acupuncture points to treat clinical conditions (Bjordal et al., 2008). It has been well documented that laser acupuncture has obvious therapeutic effects on blood pressure (Hsu et al., 2007). In a study reported in 1991, Odud and Potapenko used low-level laser beams to stimulate acupuncture points to treat hypertension (Odud and Potapenko, 1991). In a study by Sobetskii (2003) reported in 2003, approximately 368 patients with stage I and II hypertensive disease were examined and treated either with laser puncture, or acupuncture. Laser puncture was effective for stage I hypertensive disease, whereas acupuncture had a more potent hypotensive effect, and was effective for both stage I and stage II hypertensive disease. In a study reported in 2008 by Zhang et al. (2008), 55 volunteers were treated with laser acupuncture. Significant changes in blood pressure after 12 weeks of treatment at hegu (LI4) and Quchi (LI11) acupoints were reported, but there were no significant changes in HRV or obesity. In a study reported in 2008 by Hausmann et al., healthy volunteers that received low-level laser beams at three acupoints simultaneously (PC6, LR3, SI3) exhibited a significant change in HRV (Bjordal et al., 2008). In 2009, Wu et al. reported that laser acupuncture treatment affected autonomic nervous system modulation in night shift workers, who exhibited a change in HRV. The major finding of our study was a significant decrease in the subjects' blood pressure. To date, neural pathways for laser acupuncture remain unknown, but a previous study reported that laser acupuncture can activate areas of the human cortical brain by stimulating acupuncture points (Siedentopf et al., 2002). This may lead to a modulation of the neuronal network. After comparing the two groups, subjects that received the actual treatment had a noticeable decrease in their blood pressure, and exhibited an improvement in HRV.

The current study had many limitations, including the small sample size of 18 subjects, and the lack of long-term follow-up after the treatment period. The study also did not investigate how long-lasting the effect of the treatment was. We did not provide information to the subjects with regard to controlling their blood pressure and HRV during the study period; the best results for hypertension management could be achieved by combining laser treatment with patient education. This important component may be added in future studies, as the effectiveness of acupuncture treatment for hypertension is still under investigation. More studies are needed to investigate the effect of laser acupuncture therapy on blood pressure.

CONCLUSIONS

Autonomic dysfunction may cause abnormal blood pressure, via excitation of the sympathetic nervous system and inhibition of the parasympathetic nervous system. Long-term imbalances in the autonomic nervous system may lead to various cardiovascular and other chronic diseases. Laser acupuncture treatment had a positive effect on reduction of blood pressure in this study. We found that using laser acupuncture at the Taichong acupoint (LR3) helps to adjust autonomic nervous system balance. Thus, laser stimulation of the Taichong acupoint appears to have a “real time” effect on autonomic nervous system balance. We believe this phenomenon requires further investigation to clarify our knowledge of these effects.

References

Bjordal, J. M., Lopes-Martins R. A., Joensen, J., Couppe, C., Ljunggren, A. E., Stergioulas, A., Johnson, M. I. (2008). A systematic review with procedural assessments and meta-analysis of low level laser therapy in lateral elbow tendinopathy (tennis elbow). BMC Musculoskelet. Disord., 9:75.

Chang, S., Chao, W. L., Chiang, M. J., Li, S. J., Lu, Y. T., Ma, C. M., Cheng, H. Y., Hsieh, S. H. (2008). Effects of acupuncture at Neiguan (PC 6) of the pericardial meridian on blood pressure and heart rate variability. Chin. J. Physiol., 51:167–177.

Chobanian, A. V., Bakris, G. L., Black, H. R., et al. (2003). Seventh report of the Joint National Committee on prevention, detection, evaluation, and treatment of high blood pressure. Hypertension, 42:1206–1252.

Essential Medicines and Health Products Information Portal. A World Health Organization resource. Accessed from: http://apps.who.int/medicinedocs/en/d/Js4926e/

Haker, E., Egekvist, H., Bjerring, P. (2000). Effect of sensory stimulation (acupuncture) on sympathetic and parasympathetic activities in healthy subjects. J. Auton. Nerv. Syst., 79:52–59.

Hausmann, B. (2008). Changes in heart rate variability (HRV) during low level laser-needle acupuncture. German Journal of Acupuncture & Related Techniques, 51:17–23.

Health and Welfare Department of the Ministry of National Health. Accessed from: http://health99.doh.gov.tw/txt/HealthyHeadlineZone/HealthyHeadlineDetai.aspx?TopIcNo=6798

Heart rate variability: standards of measurement, physiological interpretation and clinical use. (1996). Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. Circulation, 93:1043–1065.

Hsu, C. C., Weng, C. S., Sun, M. F., Shyu, L. Y., Hu, W. C., Chang, Y. H. (2007). Evaluation of scalp and auricular acupuncture on EEG, HRV, and PRV. Am. J. Chin. Med., 35:219–230.

Huand, D., Zhang, L. (2009). Clinical study on therapeutic effect of essential hypertension with acupuncture and moxibustion. Journal of Liaoning university of TCM, 11.

Hubscher, M., Vogt, L., Banzer, W. (2007). Laser needle acupuncture at Neiguan (PC6) does not mediate heart rate variability in young, healthy men. Photomed. Laser Surg., 25:21–25.

Hung, C., Lin, J., Chen, G., et al. (2004). Immediately decreased effect of blood pressure by acupuncture on essential hypertension. J. Int. Chin. West. Med., 6:29–40.

Huan-lin, W. U., Li, X., Wang, X. (2008). The immediate effect on blood pressure of acupuncture at Taichong (LR 3) in 65 cases of hypertension patient with hyperactivity of liver-yang. Journal of Traditional Chinese Medicine, 7:622–624.

Kuo, T. B., Lin, T., Yang, C. C., Li, C. L., Chen, C. F., Chou, P. (1999). Effect of aging on gender differences in neural control of heart rate. Am. J. Physiol., 277:H2233–H2239.

Li, Z., Wang, C., Mak, A. F., Chow, D. H. (2005). Effects of acupuncture on heart rate variability in normal subjects under fatigue and non-fatigue state. Eur. J. Appl. Physiol., 94:633–640.

Macklin, E. A., Wayne, P. M., Kalish, L. A., Valaskatgis, P., Thompson, J., Pian-Smith, M. C., Zhang, Q., Stevens, S., Goertz, C., Prineas, R. J., Buczynski, B., Zusman, R. M. (2006). Stop Hypertension with the Acupuncture Research Program (SHARP): results of a randomized, controlled clinical trial. Hypertension., 48:838−845.

Mester, E., Mester, A. F., Mester, A. (1985). The biomedical effects of laser application. Lasers Surg. Med., 5:31–39.

Moriyama, Y., Moriyama, E. H., Blackmore, K., Akens, M. K., Lilge, L. (2005). In vivo study of the inflammatory modulating effects of low-level laser therapy on iNOS expression using bioluminescence imaging. Photochem. Photobiol., 81:1351–1355.

Odud, A. M., Potapenko, P. I. (1991). The use of laser puncture for managing hypertensive crises. Vrach. Delo., 7:34–36.

Pavithran, P., Mithun, R., Jomal, M., Nandeesha, H. (2008). Heart rate variability in middle-aged men with new-onset hypertension. Ann. Noninvasive Electrocardiol., 13:242–248.

Schroeder, E. B., Liao, D., Chambless, L. E., Prineas, R. J., Evans, G. W., Heiss, G. (2003). Hypertension, blood pressure, and heart rate variability: the Atherosclerosis Risk in communities (ARIC) study. Hypertension, 42:1106–1111.

Siedentopf, C. M., Golaszewski, S. M., Mottaghy, F. M., Ruff, C. C., Felber, S., Schlager. A. (2002). Functional magnetic resonance imaging detects activation of the visual association cortex during laser acupuncture of the foot in humans. Neurosci. Lett., 327:53–56.

Sobetskii, V. V. (2003). Laser-, ultraphono-, and acupuncture in complex treatment of patients with hypertension. Vopr. Kurortol. Fizioter. Lech. Fiz. Kult., 2:7–10.

Weber, M., Fussganger-May, T., Wolf, T. (2004). Needles of light: A new therapeutic approach. Medical Acupuncture, 19:141–151.

Wu, J. J., Chen, H. Y., Chang, Y. J., Wu, H. C., Chang, W. D., Chu, Y. J., Jiang, J. A. (2009). Study of autonomic nervous activity of night shift workers treated with laser acupuncture. Photomed. Laser Surg., 27:273–279.

Zhang, J., Marquina, N., Oxinos, G. (2008). Effect of laser acupoint treatment on blood pressure and body weight-a pilot study. J. Chiropr. Med., 7:134–139.

Author Information

Mei-Chih Tsai, M.D.
Department of Emergency Medicine, Chu Shang Show Chwan Hospital
Taiwan (R.O.C.)
drcmc1225@yahoo.com.tw

Yuh-Hai Wang, Ph.D
Graduate Institute of Natural Healing Sciences, Nanhua University
Taiwan (R.O.C.)