



Effectiveness of Multiwave Locked System Laser therapy in treatment of Carpal Tunnel Syndrome Patients

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Abstract

The effectiveness of Multiwave Locked System (MLS) laser therapy was evaluated in a total of 30 patients, aged more than 20 years old with mild to moderate carpal tunnel syndrome (CTS) with a single-blinded randomized controlled study. The patients were randomly assigned into intervention and control groups. The intervention group received 12 sessions of MLS laser treatment at a dosage of 15.01 J/cm² per session over the carpal tunnel area and thenar area innervated from median nerve and conventional rehabilitation treatment. The control group received placebo laser therapy that consisted of red light from flashlights covered with red cellophane without laser power output shined over the region, duration and frequency same as the intervention group. The patients were evaluated with the following parameters: (1) clinical parameters which consisted of symptom severity scale (SSS), functional status scale (FSS), visual analog scale (VAS) and EQ-5D-5L before treatment and follow-ups at 4 and 12 weeks, (2) electrophysiological parameters which were evaluated before treatment and follow-up at 12 weeks and (3) assessment for satisfaction of the service at 4 and 12 weeks. Thirty patients (52 hands: unilateral CTS=8 hands and bilateral CTS=44 hands) completed the study. Both groups had n=15 patients. The improvements were significantly more pronounced in the intervention group than control group ($p < 0.05$) especially for VAS and Compound muscle action potential (CMAP) amplitude of the median nerve at 12 weeks follow-up. MLS laser therapy coupled with conventional rehabilitation treatments is an effective treatment option in mild to moderate degree CTS before proceeding to surgery. It can clinically improve especially for VAS and electrophysiological parameter with a carry-over effect up to 3 months.

Keywords: Carpal tunnel syndrome, Multiwave Locked System (MLS) laser therapy

Introduction

Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy which is caused by compression of the median nerve within carpal tunnel. The average prevalence in the general population was 9.2% in women and 0.6% in men (De Krom et al., 1992). However, higher prevalence was detected in some specific occupational groups with presence of high-repetitive hand use or exposing to hand-arm movements or vibrations such as, grinders, butchers, cashiers and computer users (Suwannawong, Teeranet, & Rukhamet, 2001; Thomsen, Hansson, Mikkelsen, & Lauritzen, 2002). The symptoms of CTS are gradual

onset of numbness, tingling, pain or burning sensation and paresthesia in the median nerve distribution of the hand. Symptoms are worsen at night and some patients suffer from weakness and loss of dexterity of the affected hand (Muller et al., 2004). The diagnosis is based on clinical and electrophysiological testing. Management of CTS could be categorized into surgical treatment for carpal tunnel release and non surgical includes non steroidal anti-inflammatory drugs (NSAIDs), local steroid injection, wrist splint, tendon gliding exercises, acupuncture and physical modalities such as therapeutic ultrasound or low-level laser therapy and patient education for avoiding repetitive wrist movements; especially wrist flexion associated with



prolonged grip activities (Elwakil, Elazzazi, & Shokeir, 2007; O'Connor, Marshall, & Massy-Westropp, 2003; Piazzini et al., 2007).

Laser therapy is the therapeutic method widely used in physical medicine and rehabilitation regarded as one of the popular alternatives and become an increasingly adopted method of physical parameter (Hashmi et al., 2010). It is an effective noninvasive conservative treatment for accelerating healing process and reducing pain (Chow, Johnson, Lopes-Martins, & Bjordal, 2009). Anti-inflammation and nerve-regeneration stimulation effects were the characteristics have been proven (Wu, Xing, Gao, & Chen, 2009). Laser biostimulation causes changes in cellular metabolism reflected in increased intensity of ATP synthesis, increased protein synthesis (DNA and RNA), increased cellular proliferation, increased enzyme activity (e.g. ATPase), increased number of mitochondria, and increased membrane potential. Tissue oxygen supply is improved through increased blood perfusion and accelerated hemoglobin dissociation (Chow et al., 2009; Huang et al., 2009; Karu, 2008). The study with low level laser therapy (LLLT) demonstrated effectiveness for conservative treatment for CTS which alleviated clinical symptoms and improved electrophysiological parameters (Evcik, Kavuncu, Cakir, Subasi, & Yaman, 2007; Shoostari et al., 2008; Chang, Wu, Jiang, Yeh, & Tsai, 2008; Fusakul, Aranyavalai, Saensri, & Thiengwittayaporn, 2014), probably due to biological effect in neural tissue that can facilitate nerve regeneration (Basford et al., 1993). However some publications failed to confirm a significant effect of laser therapy (Irvine, Chong, Amirjani, & Chan, 2004; Tascioglu, Degirmenci, Ozkan, & Mehmetoglu, 2012). In the recent years, laser radiation is triggered by constant research into new types of laser devices. The Multiwave Locked System (MLS) laser emission impulse was approved by the

United States Food and Drug Administration (U.S. FDA) based on two combined and synchronized LLLT, while the other has the typical characteristics of high power pulse wavelength, continuous mode 808 nm and pulse mode 905 nm. The components of MLS laser therapy have been demonstrated to accelerate and improve the quality of nerve regeneration in rats after lateral neurotomy of the ulnar and median nerves. *In vivo* studies, it was found that a complete remyelination at the level of the median nerve, with recovery of nerve conduction and of the contraction capacity of the innervated muscle, which regains its capacity of correctly receiving the nervous stimulation (Alfonso, Jann, Massa, & Torreggiani, 2010). This type of synchronized radiation has scarcely been used, though some authors claim it has better therapeutic effects than traditional laser therapy (Hode, 2007; Hopkins, McLoda, Seegmiller, & David Baxter, 2004). In recent studies, there is a trend investigating the therapeutic effects of MLS laser and other high-intensity laser therapy in many musculoskeletal conditions such as soft-tissue injuries, osteoarthritis, and others, but RCT study for CTS patients is limited.

Several trials compared LLLT with other treatments for CTS. Yagci et al., 2009. Performed a prospective, randomized, unblinded comparison of LLLT with splinting alone. They found no differences in the primary outcome of symptom relief and small differences in the secondary outcome of electroneurophysiologic parameters. Fusakul et al., 2014. performed a double blinded randomized controlled trial of LLLT with the wrist splint compared with placebo laser and wrist splint to treat CTS, the patients in both groups were encouraged to do tendon gliding exercises. The improvements were significantly more pronounced in the LLLT treated group than the placebo laser group especially for grip



strength at 5 and 12 weeks followed up. At 12 weeks followed up, distal motor latency of the median nerve was significantly improved in the LLLT group than the placebo group ($p < 0.05$).

In this single-blinded randomized controlled study is the first RCT study to investigate therapeutic effects of MLS laser for CTS patients. The objectives of the present study were to compare the clinical and electrophysiological benefits of MLS laser therapy when combined with conventional rehabilitation treatments including wrist splint, tendon gliding exercise and education for the patients with mild to moderate CTS versus placebo laser group coupled with conventional rehabilitation treatments to detect early and long term effects of the laser treatment by assessing patients before treatment and at the end of 4 and 12 weeks.

Materials and Methods

This prospective, single-blinded randomized controlled study was approved by the ethical committee of Naresuan University. The patients with symptoms of CTS in the outpatient clinic of the Physical Medicine and Rehabilitation Department, Naresuan University Hospital, Phitsanulok, Thailand, were recruited. Diagnoses were made according to subjective symptoms, physical examination and electrophysiologic testing. Sensory and motor nerve conduction study was performed in all patients from the guidelines of the American Association of Electrodiagnostic Medicine (Stevens, 1997). Mild to moderate CTS patients aged more than 20 years old. Patients were excluded if they had 1) severe degree CTS, 2) central or peripheral neuropathy, 3) infection, inflammation in wrist or hand, 4) tendinitis or arthralgia in wrist or hand, 5) obvious space

occupying lesion at the wrist, 6) the nar muscle atrophy, 7) history of local steroid injection less than 6 months, 8) history of carpal tunnel surgery, 9) pregnancy, 10) rheumatic diseases such as rheumatoid arthritis, 11) inability to discontinue analgesics, 12) communication disorder, 13) light or laser allergy and 14) unwillingness to participate in the present study. Thirty five patients were eligible to enter the study (Figure 1).

Randomization and study procedures

The recruited patients were randomly assigned into two groups for intervention and control groups. Patients in the intervention group were treated with MLS laser device, Mphi 5 (ASA, Arcugnano (VI), Italy). The multidiodic applicator composed of 3 MLS sources for two wavelength (808 and 905 nm) for 12 sessions at a dosage of 15.01 J/cm^2 per session over the carpal tunnel area and thenar area innervated from median nerve and conventional rehabilitation treatments including wrist splint, tendon gliding exercise and patient education (Fusakul et al., 2014). In the control group, patients were treated with placebo laser and conventional rehabilitation treatments. Both groups were primarily compared at before treatment and at the end of 4 weeks and 12 weeks. Stratified sampling program was used. The random allocation sequence was concealed until the interventions were assigned. Blinding attempts were made to keep the patients from knowing their group of treatment during laser therapy.

Physiatrist performed clinical diagnosis, electrophysiologic testing and conventional rehabilitation treatments, the physiotherapist provided treatment MLS laser and outpatient nurse was responsible for evaluation of the outcomes.

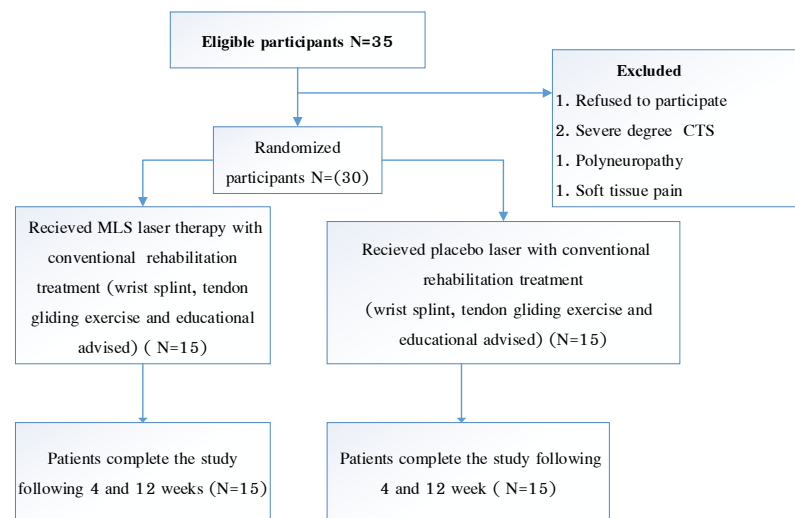


Figure 1 The protocol of the study

Outcome measures

A laser treatment had 12 sessions lasting 4 weeks, which corresponds to the usual regimen of physical therapy at our institute. In order to monitor the immediate and long-term responses to the treatment, patients were examined before treatment, immediately after the completion of the 12 session at 4 and 12 weeks. Assessments of primary outcomes were made by the following parameters: (1) clinical parameters of the visual analog scale (VAS), the symptom severity scale (SSS) and the functional status scale (FSS) and (2) electrophysiological parameters of NCS. Secondary outcomes were measured by the new 5 level of EQ-5D (EQ-5D-5L) health status measure and asking a patient how he or she responded and pleased to the treatment. A self-administered questionnaire for CTS was evaluated by the Boston questionnaire which involved SSS and the FSS (Levine et al., 1993). The SSS had 11 questions, and the FSS had 8 questions. A patient answered each question on a scale of 1 to 5 points, by which 1 indicated no symptom or no difficulty with activity while 5 indicated most severe pain or cannot perform activity at all. The questionnaire was already

translated into Thai (Uphatham & Kumnerdee, 2008).

Pain measured by VAS with 10 cm length, 0 indicated no pain at all, while 10 the most pain imaginable. EQ-5D-5L is the standardized instrument used as a measure of health outcome. A patient answered each question to indicate his/her health status by ticking (or placing a cross) in the box against the most appropriate statement in each of the 5 dimensions. This decision results in a 1-digit number expressing the level selected for that dimension. The digits for 5 dimensions can be combined in a 5-digit number describing the respondent's health state for mobility, self care, usual activities, pain/discomfort, anxiety/depression and records the second part of respondent's self-rated health on a 20 cm vertical, visual analogue scale with endpoints labelled 'the best health you can imagine' and 'the worst health you can imagine'. This information can be used as a quantitative measure of health as judged by the individual respondents (Kimman et al., 2013).

NCS was performed with a Micromed, Myoquick 1400 ME electrodiagnostic device (Italy). Patients were examined with the arm in an out stretch



position. The skin temperature of the hand and forearm temperatures were not allowed below 32°C. Median sensory measurements were recorded with ring electrodes at the third digit antidromically. The distance between stimulation at the wrist and the active electrode was 14 cm. The distal sensory latencies (DSL) were measured from the peak of the first negative peak; amplitudes of the sensory nerve action potential (SNAP) were determined from peak to peak. Median motor measurements were recorded with surface electrodes from the abductor pollicis brevis muscle orthodromically. The standard distance between stimulation at the wrist and the recording electrode was 8 cm. Median distal motor latencies (DML) at the wrist and amplitudes of the compound muscle action potential (CMAP) at the wrist and elbow were measured and determined from peak to peak. CTS were diagnosed according to minimonograph #26 of the American Association of Electrodiagnostic Medicine (Stevens, 1997).

Measurements of >3.6 ms for DSL or >4.2 ms for DML were used to diagnose CTS. Median-ulnar mixed nerve latencies by orthodromic stimulation were measured by using surface electrodes at the median and ulnar nerve area at the wrist and by stimulating the palmar branches of the median and ulnar nerves in the palmar a distance of 8 cm from the active electrodes. CTS was diagnosed when the median-ulnar latency differences were >0.5 ms. Ulnar sensory nerve conduction studies were performed to exclude the possibility of other disorders. Needle electromyography technique for detected axonal degeneration was performed to exclude severe CTS or confirms the diagnosis of cervical radiculopathy if clinically effected.

A patient's assessment of their responded to treatment and satisfaction with life scale in 7 levels, from level 1 for strongly disagree to level 7 for strongly agree for satisfaction showed both group satisfied for treatment outcome (Pavot & Diener, 1993). SSS, FSS, VAS, EQ-5D-5L were evaluated before treatment and 4 and 12 weeks later. Electrophysiological parameter was evaluated before and 12 weeks after treatment and assessment for patient's satisfaction of the service at 4 and 12 weeks after the treatment.

Therapeutic interventions in the laser group, MLS laser beam was applied at the distal wrist crease and thenar eminence area which innervated from median nerve, the landmark at Abductor pollicis brevis muscle. Dose supplied 15.01 J/cm², frequency 700 Hz and duration 10 min for 2 points, total dose of treatment is 600.36 Joules for session. The source of laser beam was placed 10 cm. away from the skin (Figure 2a, Figure 2b). Each patient was treated with laser therapy for 12 sessions in total over a period of 4 weeks (three times per week) and conventional rehabilitation treatment. All patients were prescribed prefabricated neoprene splint (Futuro, USA) set in neutral position for 12 weeks during the night time and during the daytime whenever possible (Figure 2c). In control group, the patients received a placebo treatment that consisted of red light from flashlights covered with red cellophane without laser power output shined over the region, duration and frequency same as the intervention group received (Figure 2d). The control group also had conventional rehabilitation treatment same as the intervention group.

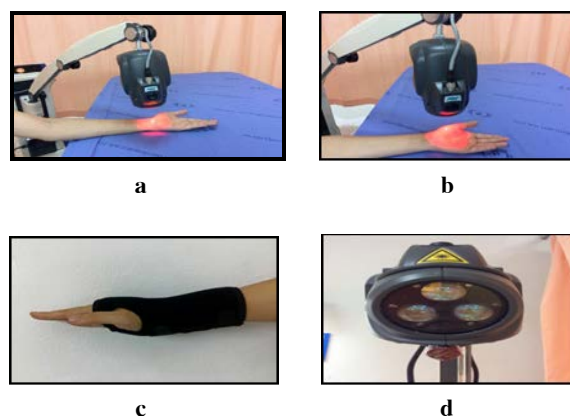


Figure 2 Illustration of MLS laser therapy: (a) over the region of CTS, (b) over the thenar eminence, (c) neutral wrist splint, and (d) placebo red light.

Statistical analysis

Demographics and clinical characteristics between intervention and control groups were expressed as mean (SD) or median (minimum–maximum) for continuous variables or as a percentage of the group of origin for categorical variables. Comparative analysis of categorical variable was performed using the Chi-square test or Fisher’s exact test. Continuous variables were analyzed by Independent *t* tests for between–group comparison. Paired *t* test was employed for within group comparison. All *p* values were two–tailed, and a *p* value < 0.05 was considered to indicate statistical significance. All statistical analyses in this study were performed using SPSS software (version 17.0).

Results

The total of 30 patients (52 hands: unilateral CTS = 8 hands and bilateral CTS = 44 hands) completed the study. Each group had 15 patients. All patients had mild to moderate CTS, according to the inclusion and exclusion criteria. No significant differences in the demographic data and baseline measurements were found between groups (Table 1). In both groups showed statistically significant improvements as assessed by SSS, FSS and VAS after 4 and 12 weeks of the treatment when compared to before the treatment but non significant between groups at 4 weeks. At the end of treatment at 12 weeks, only VAS parameters were also significantly improved in the intervention group more than control group (*p*=0.016) as shown in table 2.

Table 1 The demographic data and characteristics of the patients

	Intervention group (n=15)	Control group (n=15)	<i>P</i> -value
Age (year; mean±SD)	54.60±10.582	52.53±12.200	0.309
Gender			
Male	0 (0.00%)	1 (6.67%)	0.583
Female	15 (100%)	14 (93.34%)	
Body mass index (mean+SD)	24.32±2.959	24.93±3.702	0.414
Employment type			
Manual	10 (66.66%)	9 (60.00%)	0.900
Non–manual	5 (33.33%)	6 (40.00%)	



Table 1 (Cont.)

	Intervention group (n=15)	Control group (n=15)	P-value
Underlying disease			
NO	5 (33.34%)	9 (60.00%)	0.143
Yes	10 (66.67%)	6 (40.0%)	

Table 2 Comparison of clinical parameters between pre and post treatment at 4 and 12 weeks and between groups.

	Intervention Group			Control group			Baseline	4 weeks	12 weeks
	Baseline	4 weeks	12 weeks	Baseline	4 weeks	12 weeks	P-value	P-value	P-value
SSS	2.17±0.39	1.63±0.36	1.53±0.28	2.14±0.66	1.90±0.67	2.06±0.97	0.879	0.189	0.050
FSS	1.79±0.47	1.42±0.35	1.40±0.35	1.67±0.69	1.41±0.58	1.60±0.66	0.559	0.962	0.332
VAS	4.49±2.77	1.27±1.24	1.37±1.26	2.77±2.89	2.43±2.08	3.29±2.62	0.086	0.077	0.016*

VAS visual analog scale for pain, SSS symptom severity scale, FSS functional status scale

*Significantly different between groups ($p < 0.05$)

Most of the electrophysiological parameters showed no statistically significant differences between before and after treatment within the same group and between the groups at baseline and 12 weeks after treatment. However, CMAP after 12 weeks showed statistically significant differences between the intervention and control groups (Table 3). From both groups, a total of 2 hands (13.33%) reported side effects from the splints from wrist-hand discomfort. No patient had complication from laser treatment. Patients in both groups assessed their responses to treatment from EQ-5D-5L for evaluation quality of life and satisfaction of treatment in 2 categories after

4 and 12 weeks. In EQ-5D-5L questionnaires, at the end of treatment at 4 weeks showed no significant different between group but evaluated at 12 weeks, only dimension of pain/discomfort parameters were also significantly improved in the intervention group more than control group ($p=0.046$) as shown in table 4. In both groups assessed their responses to treatment and satisfaction with life scale in 7 levels, from level 1 for strongly disagree to level 7 for strongly agree for satisfaction. Both groups satisfied with the treatment outcome and significantly different in the intervention group (Table 5).

Table 3 Comparison of electrophysiological parameters between pre- and post-treatment and between groups

	Intervention group		Control group		Baseline	12 weeks
	Baseline	12 weeks	Baseline	12 weeks	P-value	P-value
DSL	3.60±1.34	3.31±1.35	3.07±0.96	3.24±0.92	0.222	0.869
SNAP	16.54±11.31	19.71±12.75	17.58±8.22	20.05±8.87	0.777	0.934
DML	5.06±1.57	4.75±1.52	4.77±1.46	4.89±1.41	0.593	0.800
CMAP	6.70±2.44	7.21±2.33	6.34±2.02	5.60±1.62	0.675	0.041*
NCV	45.120±10.58	46.90±11.96	46.57±11.90	49.12±7.27	0.668	0.489

DSL distal sensory latency, SNAP sensory nerve action potential amplitude, DML distal motor latency, CMAP compound muscle action potential amplitude

*Significantly different between groups ($p < 0.05$)

**Table 4** Comparison of EQ-5D-5L between pre- and post-treatment and between groups

EQ- 5D-5L	GroupI			GroupII			0 week	4 weeks	12 weeks
	0 week	4 weeks	12 weeks	0 week	4 weeks	12 weeks	<i>P-value</i>	<i>P-value</i>	<i>P-value</i>
1.health state for mobility	1.40±0.50	1.40±0.63	1.47±0.64	1.20±0.56	1.40±0.91	1.40±0.91	0.314	1.000	0.818
2.self care	1.20±0.56	1.07±0.25	1.07±0.25	1.27±0.70	1.47±0.83	1.53±0.99	0.776	0.087	0.088
3.usual activities	1.60±0.63	1.73±0.79	1.53±0.51	1.73±1.03	1.60±0.98	1.60±0.91	0.673	0.687	0.807
4.pain/discomfort	2.13±0.83	1.67±0.72	2.60±0.63	2.20±1.14	1.87±1.12	3.07±0.59	0.857	0.567	0.046*
5.anxiety/depression	1.33±0.48	1.27±0.59	1.33±0.48	1.73±0.88	1.40±0.91	1.60±8.28	0.136	0.638	0.292
6.respondent's self-rated health	75.00±10.00	84.87±6.94	82.93±7.07	67.67±21.88	78.13±15.60	73.33±24.61	0.248	0.138	0.158

EQ-5D-5L is the standardised instrument for use as a measure of health outcome. The digits for 5 dimensions and records the respondent's self-rated health on a 20 cm vertical, visual analogue scale.

Table 5 Assessments for treatment response and satisfaction by patients in both groups after treatment for 4 weeks and 12 weeks

Treatment outcomes	group Intervention		Control group		4 weeks	12 weeks
	4 weeks	12 weeks	4 weeks	12 weeks	<i>P-value</i>	<i>P-value</i>
1.Treatment response (improvement)	6.13±0.74	6.07±0.70	4.0±1.47	5.07±1.38	0.004*	0.019*
2.Satisfaction for the treatment	6.33±0.72	6.33±0.72	5.13±1.55	5.20±1.42	0.011*	0.010*

Discussion and Conclusions

The American Academy of Neurology recommends treatment of CTS with noninvasive options (eg, wrist splints, modification of activities and medication) first, and using invasive steroid injections or open carpal tunnel release only if noninvasive treatment proved to be ineffective (American Academy of Neurology, 1993). The current evidence shows a significant short term improvement after wrist splinting and immobilization. One randomized controlled study has proved that night-time wear of an innovative soft hand brace for 4 weeks was associated to a significant improvement in symptoms and functions as measured with the Boston Carpal tunnel Symptom Questionnaire. Nobuta, Sato, Nakagawa, Hatori, and Itoi (2008) reported the time of the splint for start in relief of symptom in the excellent case was 1.5 ± 0.7 months and limitation of splinting in relief of symptom after

5 months. (Levine et al., 1993). Burke, Burke, Stewart, and Cambre (1994). Another study compared the efficacy at 3 months revealed significant improvements in the symptoms of patients who were symptomatic only at night more than in the sustained symptomatic group and splinting for 3 months alone had no effect on the functional status and electrophysiological parameters for the treatment of CTS. They suggested night splinting alone as an initial therapy which may be sufficient for patients with symptoms occurring only at night. However combined treatment methods should be suggested for patients with sustained symptoms (Halac et al., 2015).

In the recent years, LLLT has been found to have positive effects in the treatment of CTS. Previous studies designed showed the efficacy of LLLT have had controversial outcomes (Fusakul et al., 2014). Evcik et al. (2007) Compared the LLLT group and placebo laser group. In the laser group they use Ga-Al-As laser with a wavelength of 830 nm and a



dosage of 14 J at two points over the carpal tunnel area 5 times per week for 10 times. Control group was treated with a placebo laser. They found statistically significant improvements in VAS, pinch strength, and FSS in both groups than before treatment but in the laser group hand grip was improved. In electrophysiological parameter, they found that the laser group improved in SNCV, sensory and motor distal latencies ($p < 0.001$) but only SNCV was meaningful in the control group. Fusakul et al. (2014) compared LLLT and placebo laser to treat mild to moderate CTS. They found the improvements were significantly more pronounced in the LLLT treated group than the placebo group especially for grip strength at 5 and 12 weeks follow-up. At 12-week follow-up, distal motor latency of the median nerve was significantly improved in the LLLT group than the placebo group ($p < 0.05$).

Multiwave Locked System (MLS) laser therapy, characterized by a synchronized emissions of two wavelengths of 808 nm (in continuous mode) and 905 nm (as a pulsed laser light), is a new technique used in order to increase the effect of laser irradiation. Two emissions are absorbed by different mitochondrial complexes and can affect cellular energy metabolism by acting on multiple sites in the cellular respiratory chain at the same time. Continuous emission is absorbed by the cytochrome oxidase which activation promotes the production of ATP, leading to the anti-inflammatory and anti-oedematous effects by stimulating microcirculation and influencing on the synthesis and degradation of inflammatory mediators Hegedus, Viharos, Gervain, and Galfi (2009). Pulsed emission reduces pain through an effect on the superficial nociceptors and afferent nervous fibres, influencing on the nerve conduction (Konstatinovic, Cutavic, & Milovanovic, 2010). The result of this

emission is an increase of the nociceptive threshold and in a consequence a reduction of pain sensation. Synchronization of both radiation components intensifies the analgesic, anti-inflammatory and anti-oedematous effect, increasing the intensity of the therapeutic effect on both pain and inflammation.

To our knowledge, the present study is the first prospective, randomized, single-blinded, controlled study to compared the effectiveness of MLS laser therapy coupled with conventional rehabilitation treatments included wrist splint, tendon gliding exercise and education with the control group included placebo laser couple with conventional rehabilitation treatment in mild to moderate CTS patients. The dose regiment, duration and frequency of treatment is referenced from other previous LLLT study (Fusakul et al., 2014). The results from our study showed that improvements as assessed by SSS, FSS and VAS after 4 weeks in both groups but at the end of treatment at 12 weeks, only VAS parameters were also significantly improved in the intervention group more than control group. This result correlated with dimension of pain/discomfort parameters of EQ-5D-5L evaluated at 12 weeks were significantly improved in the intervention group more than control group ($p = 0.046$), moreover both groups satisfied with the treatment outcome but significantly different in the intervention group. Compared with previous study of LLLT, MLS laser therapy showed a success rate of pain relief in CTS patients in shorter duration of treatment and sustained effect in 12 weeks. (Fusakul et al., 2014; Yagci et al., 2009).

Electrophysiological parameter of CMAP in the intervention group after 12 weeks followed up showed statistically significant differences between the intervention and control groups. It is postulated that MLS radiation can interact with deep located tissue and influence on the permeability of the cellular membrane, vessel walls from anti-



inflammatory and anti-edematous effect and peripheral nervous system from anti-analgesic effect and re-innervation of peripheral nerve (Kuryliszyn-Moskal et al., 2015).

The first limitation of this study is the small sample size that limits the power of the study. Secondly, Single blinded study may introduce expectation and assessment bias. Thirdly, the analgesic medications were washed out before enrollment. However 3 patients sometimes had analgesic intaked between the times of study. However, we suspected the patients to wash out analgesic prior to participation. Furthermore, none of the participants increased analgesic intake during the study. Then, the medications may not likely be a significant confounder in the present study. We suggested that a double blind placebo controlled trial should be conducted in the future.

In conclusion, it can be recommend that MLS laser therapy coupled with conventional treatments as an effective treatment option in mild to moderate degree CTS before proceeding to surgery.

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