

# Low Level Laser for Lymphoedema

## An overview of research

### Introduction

Low Level Laser Therapy (LLLT) was first introduced in the 1960's in Europe and promoted for wound healing. Since that time it has been promoted extensively around the world for muscular/skeletal pain relief and wound healing and a wide variety of other conditions with varying levels of supporting clinical evidence. Most of the research activity has been centred in Europe, however, the American Food and Drug Administration (FDA) cleared a number of Low Level Laser Therapy (LLLT) products for pain relief from 2001, following review of appropriate clinical data. Pain relief remains the most popular use of LLLT.

Low Level Laser Therapy (LLLT) was introduced as a potential treatment for lymphoedema by Piller and Thelander (1) in 1995. Since that time there have been numerous published clinical studies, cell and tissue studies and studies presented at conferences which suggests that LLLT is a potential treatment for lymphatic disorders. The FDA has currently approved one LLLT product for lymphoedema treatment (RianCorp LTU-904). The aim of this paper is to summarise the currently available data on laser for lymphoedema and identify research that is currently underway.

### Cell and Tissue Studies

Low Level Laser Therapy (LLLT) is reported to have beneficial effects on cells and tissues. LLLT has been trialled for the treatment of fibrous scar tissue (Thelander and Piller, 2000) and has been shown to affect fibroblasts (Boulton and Marshall, 1986). These effects are important

11 clinical trials involving 390 patients report positive results

both in treating surgical scars associated with postmastectomy lymphoedema (PML) and in treating the

brawny edema that often develops in lymphoedematous limbs. There is also a suggestion that LLLT encourages lymphogenesis and stimulates lymphatic motoricity (Leivens, 1985; Lievens, 1991). Finally, LLLT appears to affect macrophage cells (Young et al, 1989) and to stimulate the immune system (Tadakuma, 1993). All of these actions indicate that LLLT could be an appropriate treatment for post-mastectomy lymphoedema.

Possible explanations for the beneficial effect of LTU-904 treatment include;

- restoration of lymphatic drainage through the axillary region due to stimulation of new lymphatic pathways
- restoration of drainage through reduction of fibrosis and scarring of tissues in the axillary region
- reduction in tissue fluid accumulation through changes in blood flow, either directly via an effect of blood vessels or by neural regulation of vessels in the limb

Theories on the mechanism/s of action of LLLT in tissues include interaction with the cytochromes of the mitochondrial electron transport chain (Karu 1989), induction of local gradients in energy delivery due to laser speckle resulting in local gradients in cellular heating (Horváth & Donko 1992), stimulation of long term mitogenic activity (Boulton & Marshall 1986), stimulatory / protective effects on fibroblasts (Glassberg et al 1988) and on lymphocytes (Inoue et al 1989), and stimulatory / protective effects on endothelial cells and vascular endothelium in situ (Lamuraaglia et al 1992). In addition, there are reports of stimulation of local fluid circulation (Horváth & Donko, 1992), and stimulatory effects on lymphatic vessels (Lieviens et al, 1985).

### Clinical Studies

Following are summaries of 3 double blind studies, 1 single blind study, 2 randomised controlled studies and 4 case series using low level laser therapy for lymphoedema. A total of 390 patients have been included in these studies. All studies report positive effects with sustained effects reported at up to 36 months.

Studies include comparison with compression therapy (bandaging) and compression pumps and include laser use as an adjunctive therapy. In each case, the laser improved patient outcomes.

#### Piller

Piller and Thelander reported a 10 patient case series in 1998. Patients received 16 sessions of laser therapy and were followed-up for up to 36 months. Positive effects were reported.

#### Carati

Carati et al 2003, reported a randomised double blind study using LLLT on 64 post mastectomy lymphoedema patients.

Sixty-four participants (27 'placebo' stream and 37 in 'active' stream) completed the trial, which involved LLLT treatment to the axilla at 17 points at a dosage of 1.5Jcm<sup>2</sup>. No other treatment was included in the study.

1. Immediate volume reduction was not seen.
2. Mean affected arm volume was significantly reduced at one or three months follow-up after 2 cycles of active laser treatment. Thirty-one % of subjects had a clinically significant reduction in volume of their PML affected arm (>200 mls) three months after starting treatment.
3. Extracellular fluid levels (an index of edema) of the affected, and unaffected arms and torso, were significantly reduced for up to three months following 2 cycles of LTU-904 therapy.
4. There was a significant softening of the tissues in the affected upper arm.

#### Lau

Long term benefit reported 12 months after treatment

Rufina W.L. Lau et al enrolled 21 patients in a single blind study of scanning low level laser in 2009. Patients received 20 mins of

scanning laser over the axilla area at a calculated dosage of 2 jcm<sup>2</sup>. Treatment was 3 times per week for 4 weeks with follow-up at 4 weeks after treatment. Active treatment laser patients achieved 16% volume reduction at the end of 4 weeks and this improved to 28% in follow-up. The placebo group had an increase in limb volume of 6% at the follow-up assessment.

#### Kaviani

Kaviani reported a double blind study of 11 subjects (8 completed the trial) in 2005. Treatment was conducted with an 890nm laser at a dosage of 1.5 jcm<sup>2</sup>, however, only 5 points were treated. Patients received treatment 3 times per week for 3 weeks, an 8 week break and then another 3 week block. Patients were assessed at 3, 9,12,18,and 22 weeks. Limb circumference was lower in the active group than the sham treatment group, other than in week 22.

#### Wigg

Wigg reported a 12 patient case series in 2009. Patients who were unresponsive to routine treatment, or with stubborn thickening were recruited to the study. Patients received pulsed 904nm laser at 1 or 1.5 jcm<sup>2</sup> for 7-25 minutes. Treatment was delivered at 3 times/week for 2 weeks, 1/week for 4 weeks, 1/fortnight for 4 weeks and 2 monthly treatments. Patients reported positive outcomes, with 100% reporting significant improvements.

#### Dirican

Dirican et al, 2010 reported a case series of 17 patients who received LLLT in addition to conventional treatment for lymphoedema. The authors concluded that patients received additional benefits from LLLT including reduction in limb circumference, pain, increase in range of motion, increase in scar mobility. All patients used garments or bandaging for compression and 2 patients also used compression pumps. Treatment was 3/week for 3 weeks, an 8 week break, and another block of treatment of 3/week for 3 weeks.

### Ashworth, unpublished case series

Karen Ashworth (OT, California) conducted a 10 patient satisfaction questionnaire in 2007. She used laser in conjunction with manual lymphatic drainage and other standard treatments. Number of treatments ranged from one to nine with treatment times between 5 mins and 45 mins. Dosage was 1.5 Jcm<sup>2</sup>. Patients reported their outcomes; 100% of patients reporting that the laser made a significant change in their condition.

- 100% reported softer tissue
- 50% reported better lymphatic circulation
- 50% reported reduced feeling of heaviness
- 40% reported reduced pain
- 90% reported reduced volume

She completed a follow-up in 2008. Seven patients were available for follow-up. The results of the follow-up survey showed that the changes which were affected by the low level laser were maintained for one year by the available subjects.

Ashworth concluded "Given the chronic and often

progressive nature of lymphoedema, the low level laser is a significant treatment modality in increasing lymphatic circulation by working to soften tissues that are hardened by scar

“The results of low level laser therapy seems better than pneumatic compression therapy”

tissue adhesions, radiation fibrosis and lymphoedema fibrosis.”

### Lunken, case series, poster

Avril Lunken (OT Australia), presented a 10 patient case study series poster at the 2005 Aust Assoc Massage Therapists conference. She treated patients with MLD and laser over a 4 week period. Immediately after treatment 80% of patients reported improvements.

### Kozanoglu

Kozanoglu et al, Curkurova University Turkey, reported the results of a study comparing pneumatic compression and low level laser therapy in a randomised controlled trial (Clin Rehabil 2009 Feb 23(2) 117-24).

Forty seven patients with post mastectomy lymphoedema were enrolled in the study. Patients were randomly assigned to receive pneumatic compression (n=24) or low level laser (n=23). The pneumatic compression group received 2 hours of treatment 5 days per week for 4 weeks and the laser group received 20 mins of LLLT 3 times per week, treatment for 4 weeks.

Differences between the sum of the circumference of

“Outcomes better than compression pumps in 1/10th of the treatment time”

affected and unaffected limbs was decreased in both groups and the decrease was still significant at 12 month follow-up in the laser group (p = 0.004). Improvement in the laser group was greater than the pneumatic compression group post treatment and at 12 months (p=0.02). There were no significant differences in the pain scores or grip strength between the two groups.

The authors conclude that the laser group had better long term results than the pneumatic compression group. It is interesting to consider that the laser group received 240 mins of treatment and the compression group received 2400 mins of treatment.

### White

Kathryn White et al reported a randomised study comparing LLLT and standard treatment for lymphoedema in 2009. The study involved the recruiting of 148 women with mild or moderate lymphoedema. The patients were randomly assigned to receive LLLT for 2 weeks or standard compression treatment.

White reported that the women identified with mild lymphoedema, who received LLLT treatment, experienced a sustained reduction in lymphoedema in comparison with the standard group who experienced a sustained increase (p<0. 01).

Women with moderate lymphoedema experienced a reduction in lymphoedema in both groups, however the standard treatment group reported that the standard treatment was uncomfortable, time consuming, restrictive

of movement and detrimental to activities of daily living.

The authors concluded that “laser appears to be a viable option to standard treatment for women with moderate lymphoedema as the same result is achieved without the discomfort and inconvenience of standard treatment.”

### Omar

Omar et al conducted a randomised double blind study with 50 post mastectomy subjects with moderate lymphoedema (25 active and 25 placebo) in 2010. Patients were reviewed for limb circumference, shoulder mobility and grip strength. Patients received laser therapy or sham treatment 3 times per week for 12 weeks. In addition, all patients were given appropriate exercise and wore 40-60mmHg compression sleeves for 20 hours per day.

Limb reduction was greater in the active group with statistical significance at 8 and 12 weeks. External shoulder rotation was no different between the groups, however, shoulder flexion and abduction was statistically significant between groups with the active group more improved. Grip strength was improved in the active group at 12 weeks.

“Patients received additional benefits from LLLT – reduction in limb circumference, pain and increased range of motion and scar mobility”

Author	Style	n=	Treatment	Treatment Detail	Wavelength /dose	Follow-Up	Concurrent Treatments	Results
Ashworth	case series	10	1/week, 1-9 weeks	scar and fibrotic areas. 5-45 spots	904nm 1.5 Jcm <sup>2</sup>	12 months	MLD, compression pump	positive
Carati	randomised double blind	64	3 times/week, 3 weeks in two blocks	17 points in the axilla	904nm 1.5 Jcm <sup>2</sup>	3 months	none	positive at 1 month follow-up and improved at 3 month follow-up
Dirican	case series	17	3 times/week 3 weeks in two blocks	20 mins	904nm 1.5 Jcm <sup>2</sup>	not stated	general therapy	positive
Kaviani	randomised double blind	11	3 times/week for 3 weeks in two blocks	5 points	890 1.5 Jcm <sup>2</sup>	2 months	none	positive post treatment but not follow-up
Kozanoglu	randomised controlled	47	3 times/week for 4 weeks	11 points	904n 1.5 Jcm <sup>2</sup>	12 months	comparison with compression pump	positive post treatment and at 12 months in comparison with pump
Lau	randomised single blind	21	3 times/week for 4 weeks	20 mins scanning axilla	808nm & 905nm 2 Jcm <sup>2</sup>	1 month	none	positive at 4 weeks and greater at 8 weeks
Lunken	case series		1/week for 4 weeks	20 mins, 30 secs/point	904nm 1.5 Jcm <sup>2</sup>	none	MLD	80% repoted positive results
Omar	randomised double blind	50	3 times/week for 12 weeks	axilla/are 7 points	904nm 1.5 Jcm <sup>2</sup>	1 month	compression using garments or bandaging	positive at 8 and 12 weeks
Piller	case series	10	16 sessions	scanning	904nm and 630nm	36 months		positive
White	randomised controlled	148		scanning	904nm and 630nm scanning	not stated	comparison with conventional treatment	positive in comparison with conventional treatment with less time/effort
Wigg	case series	12	3 times/week, 2 weeks:1/week for 4 weeks;1/fortnight for 4 weeks: monthly x2	7-25 points, various locations	904nm 1.5 Jcm <sup>2</sup>	not stated	some patients received MLD	positive