THE PROXIMAL PRIORITY TECHNIQUE: HOW TO MAXIMIZE THE EFFICACY OF LASER THERAPY

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Reports on the efficacy of low reactive level laser therapy (LLLT) cover a range from 60% to 90%, depending on the criteria set by the authors, and also cover a large range of methodologies based on anatomical considerations, Oriental Medicine acupuncture-based tenets, or a blend of the two. From his experience in having treated 48,145 patients (correct as of July 1st 2005) in over 25 years of practicing LLLT, the author presents an anatomically-based treatment method which gives consistently good results, and maximizes the efficacy of laser therapy in a large variety of conditions including pain attenuation, wound healing, scar revision or treatment of areas of abnormal skin colour. No matter what entity is being treated in what location, laser therapy is always started in the contact pressure method bilaterally on the side of the neck approximately 2 cm down from the ears, and then on the C1/C2 intervertebral points, the C1/C2 zone, working round the base of the skull at points about 1 cm apart while angling the laser probe upwards by about 45°. The system used is an 830 nm GaAlAs diode laser (60 mW, continuous wave, incident power density 3 W/cm^2, 10 sec/point, energy density 30 J/cm^2). Subsequent treatment points run from proximal to distal towards the final treatment site, thence the name ‘proximal priority’. Irradiation of the sides of the neck targets increased blood supply to the brain; the C1/C2 zone targets in particular the 2nd and 3rd neurons, and the cerebellum, pons and medulla oblongata, in which lie a number of important control centres including those which control blood pressure and the descending inhibitory pathway of the reticulospinal tract. By activating these centres before moving to the site of interest, it is believed that a more efficient endorphin and enkephalin synthesis is triggered in the case of pain attenuation, via activation of the reticulospinal tract through the pyramidal and extrapyramidal fibres, and the parasympathetic system is given a ‘wake-up’ call in the case of all conditions. Laser therapy applied directly to a site of interest will still have some effect, possibly a good one, but the author suggests that adherence to the proximal priority method will make a good effect even better.

Key words*:* GaAlAs diode LLLT, pain, hypertension, autonomic nervous system, parasympathetic control, descending inhibitory pathway

Introduction

The use of low reactive level laser therapy (LLLT) has dramatically increased over the past decade and a half, and in particular its efficacy in pain attenuation is now well recognized. Many intractable chronic pain types respond well to LLLT, including frozen shoulder, lateral and medial epicondylitis, arthroses and postherpetic neuralgia.[1-5] Efficacy rates range, however, from around 60% to 90%, depending on the researcher, the protocol and the criteria used, but an average of around 80% improvement in approximately 84% of patients seems to be the agreed norm.[6]

Treatment protocols vary widely, and standardization of treatment will go a long way to improving both the results obtained with laser therapy, and also its standing in the scientific community where LLLT is still somewhat regarded as a *‘bête noire’*. despite its January 2002 approval in pain control by the US FDA. Some protocols are based on an anatomical approach, using the pain areas themselves as the guides, some add trigger points around the affected zone to the pain area itself, others use laser therapy on acupuncture points in an Oriental Medicine meridian-based fashion, and still others mix acupuncture points with irradiation the painful area. With such a mixture of sometimes conflicting protocols, it is not surprising that confusion exists regarding laser therapy and its real efficacy.

Pain is only one of the facets treated with LLLT. Others include essential hypertension, hyperpigmentation and hypopigmentation, wound healing, bone repair, nerve repair, scar revision in suitable keloids, hypertrophic and depressed scars, and control of involuntary tonic spasms.

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Fig 1: The OhLase-3D1. (Left) Console type, consisting of a control console linked to the hand-held probe by a control cable. (Right) OhLase-3D1-HT portable, rechargeable battery-powered version, same parameters as the console type.

The present paper presents my own technique based on over 25 years' experience in treating over 48,000 patients with laser therapy, for the entire range of applications listed above. I call it the 'Proximal Priority' technique, or PPT, and the treatment techniques are based on the anatomical considerations of the neural, blood and lymphatic vascular systems, working from proximal (the brain and its blood supply) to distal (the area of interest).

LLLT System and Treatment Technique

I use 830 nm as my wavelength of choice, as that has been shown to have favorable effects on a large number of cell types, and thus clinically useful in pain control, wound healing of all types and other applications. I either use the OhLase-3D1 (Proli Japan, Tokyo) as my LLLT system, which is a console-controlled handheld probe-based system delivering a continuous wave (CW) 830 nm beam of 60 mW, giving an incident power density (spectral irradiance) at the point of contact of approximately 3 W/cm^2., or a fully portable, battery-powered version, the OhLase-3D1-HT (handy type), which delivers exactly the same parameters as the console type. (Figure 1)

I usually deliver a dose (energy density, or radiant flux) of around 30 J/cm^2, with 10 sec irradiation per point. I almost always use the system in the contact mode with moderate to firm pressure. This eliminates losses from the air gap between the probe and target tissue, and reflection losses from the stratum corneum of the epidermis, combined with the antireflective window set into the laser aperture. Pressure physically moves the probe head nearer the target tissue, and also mechanically blanches out the superficial microvasculature,

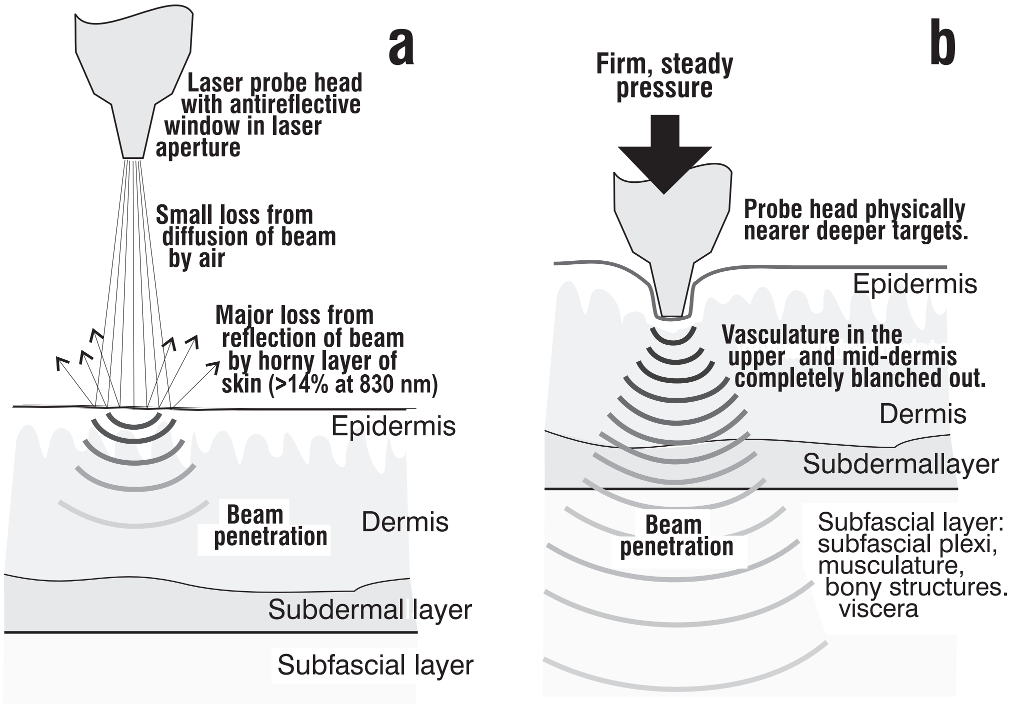

Fig 2: **a:** The noncontact method leaves an air gap between the probe and the target tissue. There will be a slight loss in transmission caused by this gap, and a much more significant loss through reflection from the stratum corneum. **b:** The contact pressure method illustrated, in which the probe head is moved physically nearer its target, loss from air and reflection are minimized, and superficial blood vessels are blanched out to allow better penetration of more photons.

thereby removing a potential target for the 830 nm near infrared beam, and allows deeper penetration of a higher photon density, thus helping to ensure a clinically useful photon density at the target depth (Figure 2).[1,7] Especially when treating conditions associated with longer nerves, such as the sciatic nerve, I use a rhythmical light percussive method in certain areas, which I call the 'woodpecker' technique.[1,7] This is particularly useful when trying to break down lympho-concentration in chronic conditions in the extremities, and limits penetration depth to more superficial targets.

In the PPT, treatment is always started bilaterally on the sides of the neck, about 2 cm below the ears, targeting the blood supply to the brain to increase cerebral blood supply and hence oxygenation. The spinal aspect of the base of the skull is next targeted, at the Atlas/Axis (C1/C2) junction. For this reason, I call this part of the PPT the C1/C2 zone. The patient is asked to extend the dorsal aspect of the neck by lowering the head anteriorly. The C1/C2 intervertebral points are irradiated in dorsal root therapy (DRT), and then subsequent points approximately 1 cm apart are irradiated, working anteriorly to the final point just by the stylomastoid foramen behind the ear. No matter what I am treating, or wherever the area of interest is, I always start my PPT with the bilateral neck and C1/C2 zone treatment points.

The next set of irradiation points depends on the entity being treated and its location. I generally then use a dermatomal-based approach, first applying dorsal root therapy (DRT) to the intervertebral points on the side ipsilateral to the region of interest (ROI), from two dermatomes above the affected dermatomes, then the main dermatomes, then two dermatomes below as the main nerve associated with each dermatome branches from multiple dorsal root exit and entry zones.

Once DRT is completed, I then work out along the path of the dermatome, with the distance between the treatments depending on the condition being treated. In general, the more chronic the condition, the smaller the distance between the points. Finally I treat the ROI itself. In the case of a pain entity, by this stage the patient is usually aware of some improvement in the level of pain even though the ROI has not yet been treated.

Example: Tennis Elbow (lateral epicondylitis)

Tennis elbow is caused by inflammation around the lateral epicondyle, the bony protuberance on the outer side of the humerus at the elbow, to which some of the forearm muscles are attached by tendons. Pain and tenderness are felt at the outer aspect of the elbow and along the back of the forearm. Tennis elbow is caused by misuse or overuse of the muscles which straighten the wrist and fingers, which in turn repeatedly jerks the tendons at the point of their attachment. Although caused by playing tennis or another racquet sport with a faulty grip, home decorating or gardening are also possible causes.

I start with light pressure and gradually increase to firm pressure, and treat in the PPT as follows:

- Before actual treatment, the patient gets an information pack which details the treatment, alternative treatments, and any possible side effects. In the case of chronic pain, the patient is advised strongly that pain will probably increase in the ROI, as it comes out of its chronic phase back into an acute phase, and from there to alleviation. This patient education program is essential in order to build and maintain the patient/therapist relationship and ensure compliance, as well as preparing the patient for the escalation of their pain when they are expecting it to be cured.
- Treat the bilateral sides of the neck
- Treat the C1/C2 zone
- The elbow falls within dermatome C7, so I apply DRT for the C5, C6, C7, C8 and T1 dermatomes
- Treat deep into the axilla to involve the brachial plexus, especially the radial nerve and its branches associated with the lateral aspect of the elbow region
- Starting proximally and working distally, treat two or more points along the anatomical course of the radial nerve: the more chronic the condition, the shorter the distance between points
- Treat around the lateral epicondyle, points approximately 0.5 cm apart
- Treat the epicondyle itself (possibly extremely tender at first, so moderate pressure for the initial treatment)
- Work towards a point 3-4 cm distal from the epicondyle, treating two or so points along the anatomical path of the radial nerve. This also involves the affected muscles, the muscle/tendon junctions, and superficial branches of the radial nerve.
- Treat any remaining particularly tender points on the affected muscles, working from proximal to distal.
- Treatments should be repeated daily (if possible) for four or five days, during which the patient should be advised to use, but not to overuse, the affected arm. Thereafter, treatment once every two or three days may be necessary, followed by once a week for eight weeks, then once every two weeks for 4 months, although the condition will usually have resolved by around the 10th treatment session.
- If the condition is caused by a racquet sport, advise the patient to seek professional advice on his or her grip to prevent recurrence.

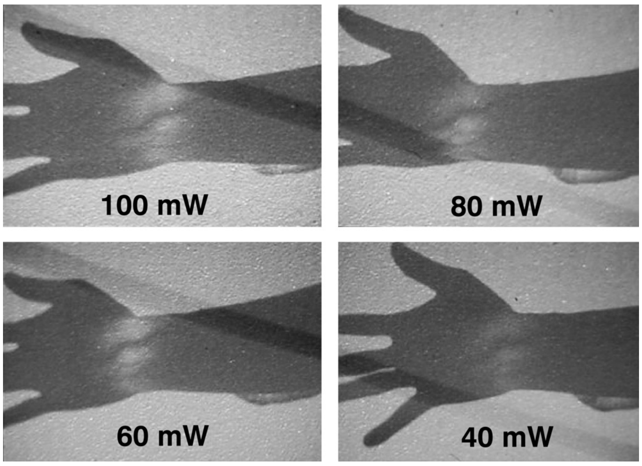

Fig 3: Human hand transilluminated with an 830 nm diode laser at 40~100 mW, captured with an infrared sensitive CCD camera. The bones of the hand and wrist are not visible, although blood vessels can be seen.

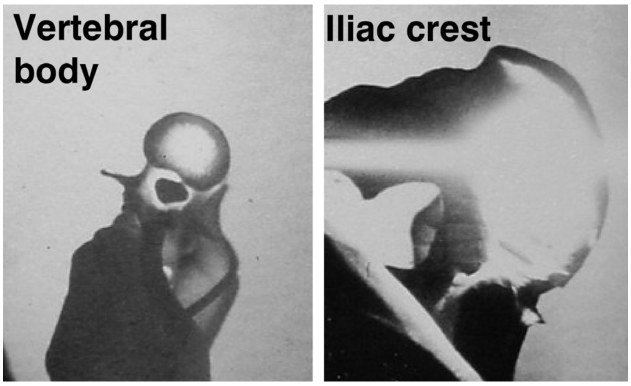

Fig 4: 830 nm laser energy shown transilluminating bone specimens, a vertebral bone on the left and an iliac crest on the right, captured with an infrared sensitive CCD camera. This shows that bony tissue is capable of transmitting laser energy, believed to be due to the crystalline component of the apatite.

Discussion

The PPT is based on my earlier ideas of the brain as the 'mother computer' of our body, connected with, sending messages to and receiving information from all the other 'computers' at whole body, tissue and cellular levels.[8] Usually, the brain works on a positive feedback mechanism with its central and peripheral system components. However, if this feedback system is compromised, then problems occur. For example, an untreated or poorly treated stabbing-type acute pain in an extremity from a musculoskeletal injury will gradually be replaced by a less acute and more pervasive dull pain, which may in turn be replaced with numbness in the ROI. The normal wound healing process is actually to blame, as the damaged tissues are replaced with dense fibrotic tissue, which can in extreme cases trap and occlude blood vessels, nerves and lymphatic vessels.

As the fibrosis develops further, the nodules become harder, causing more damage to the trapped vessels and nerves. At this stage, the tissue distal to the injury site will be suffering from vascular supply problems, perhaps indicated by coldness in the extremities, unless a collateral supply can be quickly established. For the trapped nerve, however, the problem is even greater. As part of the positive feedback system, the brain expects to have a regular and uninterrupted communication with the peripheral system. Long-term interruption of this communication leads to the brain believing that the affected nerve is no longer required, and so the affected neural cell body in the spinal ganglion, where the nerve communicates with the first neuron, is gradually allowed to deteriorate. This has been experimentally demonstrated in rat models.[9]

Treatment of the ROI directly in cases such as this may well result in some attenuation of the pain, but the problem of re-establishing communication between the damaged nerve and the brain has not been addressed, and so the damaged cell body will not be repaired. Approaching the problem proximally will have a much more logical chance of restoring full communication, allowing repair of the deteriorated spinal ganglion tissue, softening of the fibrotic nodule with release of the trapped vessels and nerves, and restoration of a good lymphatic return in addition to the blood supply and return.

Proximal Priority: Rationale

The blood supply to the brain has been shown to improve following LLLT applied to the bilateral neck, thus ensuring the 'mother computer' is in the best possible condition before moving on to the next stage. Irradiation here will also involve the second neuron. The cerebellum, pons and medulla contain some extremely important control centers and pathways, and these organs are within reach of 830 nm energy. 830 nm laser energy at 60 mW transilluminates the human hand without showing the bones (Figure 3), and was shown to be well- transmitted through specimens of bone (Figure 4).[10] The penetrative power of 830 nm was therefore tested using a skull radiographic phantom (Rand phantom, Rand laboratories, USA) based on a real human skull, and depths of penetration of over 10 cm were seen on the special IR-sensitive film which replaced the X-ray film usually used in these training phantoms (Figure 5).[11]

Given that spread of energy and area of involved tissue, applying laser energy of 830 nm to the C1/C2 zone and aiming the laser beam upwards will produce a pattern and involvement similar to Figure 6. If the head was moved forwards and downwards, then the improved target could be imagined with better involvement of the second and third neurons, and target

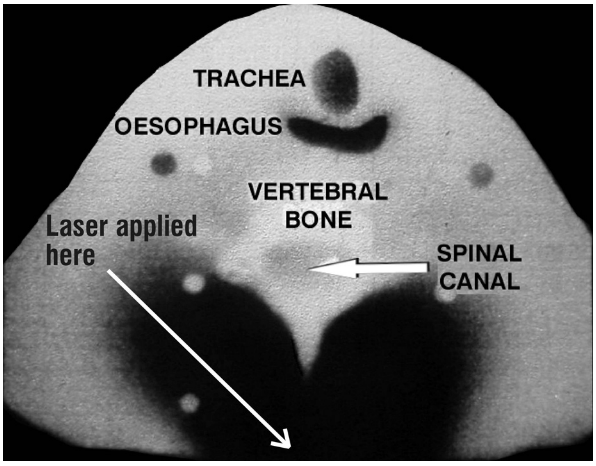

Fig 5: Involvement pattern of 830 nm diode laser energy generated on infrared-sensitive film in a radiographic phantom head model, approximately corresponding to the C6/C7 level. The darkened area on the film shows the penetration depth and scatter spread of the 830 nm laser energy, which has even involved the spinal canal.

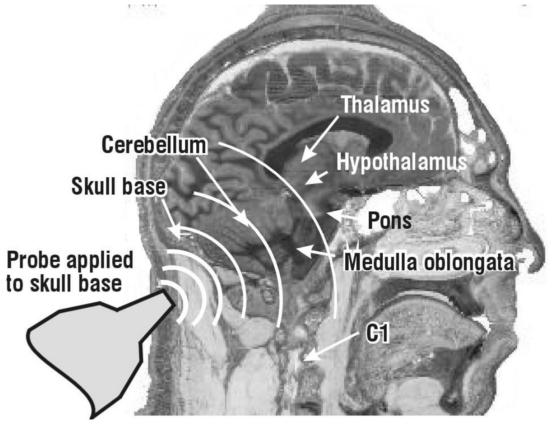

Fig 6: Schema showing possible depth of 830 nm irradiation of the C1/C2 zone superimposed on a cryosection of a human head, and the organs falling within the range of a therapeutically useful photon density. The cerebellum, pons and medulla oblongata will all be targeted. Penetration can be helped by asking the patient to drop his or her head forward.

organs. Within these latter structures lie important control centres, including the blood pressure control centre, and the centre controlling the descending parasympathetic pathway. Within the cerebellum in particular are essential cerebellar pathways, both ascending to the association fields of the cerebral cortex, and descending via the pyramidal and extrapyramidal fibres. Irradiation of the C1/C2 zone thus provides a kind of 'wake up' call which will excite these control centres and essential cerebellar pathways. The role of laser therapy in activation of the descending inhibitory pathway is well documented.[12-17]

Dorsal root therapy (DRT) continues the activation started by the lateral neck and C1/C2 zone treatment, and allows irradiation not only of the dorsal root entry and exit zones, but also, indirectly, of the neural transmission components of the spinal cord gray matter, where for example the gating of allogeneic transmissions is thought to exist. DRT is extended to two above and two below the intervertebral spaces of interest because each nerve on which a dermatome is based has roots emanating from two or more dorsal root entry/exit zones. By spreading the treatment above and then below the zones of interest, the target nerve and the dermatome it innervates will be more thoroughly activated than by simply treating the dorsal zone or zones of interest. DRT also targets the first neuron.

In pain control in particular, serotonin messaging signals the synthesis of endorphins in the upper part of the central nervous system, and activation of the lateral reticulospinal tract starts endorphin synthesis lower in the CNS, and also in the peripheral nervous system. Photoactivation of the descending inhibitory pathway, under parasympathetic control, causes general vasodilation and relaxation of sympathetic controlled units. Figure 7 on the following page shows in schematic form the mechanisms of laser therapy in pain control, resulting in enhanced systemic endorphin synthesis (narcotic analgesia, blocking receptor sites), followed by localized enkephalin synthesis (nonnarcotic analgesia, shutting down synaptic transport of neurotransmitters).[18]

To move away from pain control, Figure 8 (overleaf) illustrates the total body warming in a cerebral palsy patient following the use of the proximal priority-based regimen, as reported by Asanami *et al*. The latency of the effect was still increasing 90 minutes after the LLLT session.[19] Cerebral palsy patients are under hypertensive sympathetic control, resulting in vasoconstriction and the appearance of the 'cold' extremities and abdominal area seen in Figure 8a. The activation of the parasympathetic system resulted in vasodilation, and the return of the blood supply to the extremities and abdomen is seen in Figures 8b, 8c and 8d. In the same study, the effect of laser therapy on controlling involuntary random axonal firing and tonus/clonus was demonstrated electromyographically. These data are well in accord with Walker's earlier report on the ability of LLLT to control involuntary tonic spasms in paraplegic patients.[20] These examples illustrate the complete or partial loss of communication between the brain and the distal ROIs, and the restoration of that control through intervention at the C1/C2 zone in the PPT.

In other areas, the mechanisms are not yet totally elucidated, although the clinical effects are clear. As an important example, The effective application of LLLT in control of essential hypertension has been reported in a

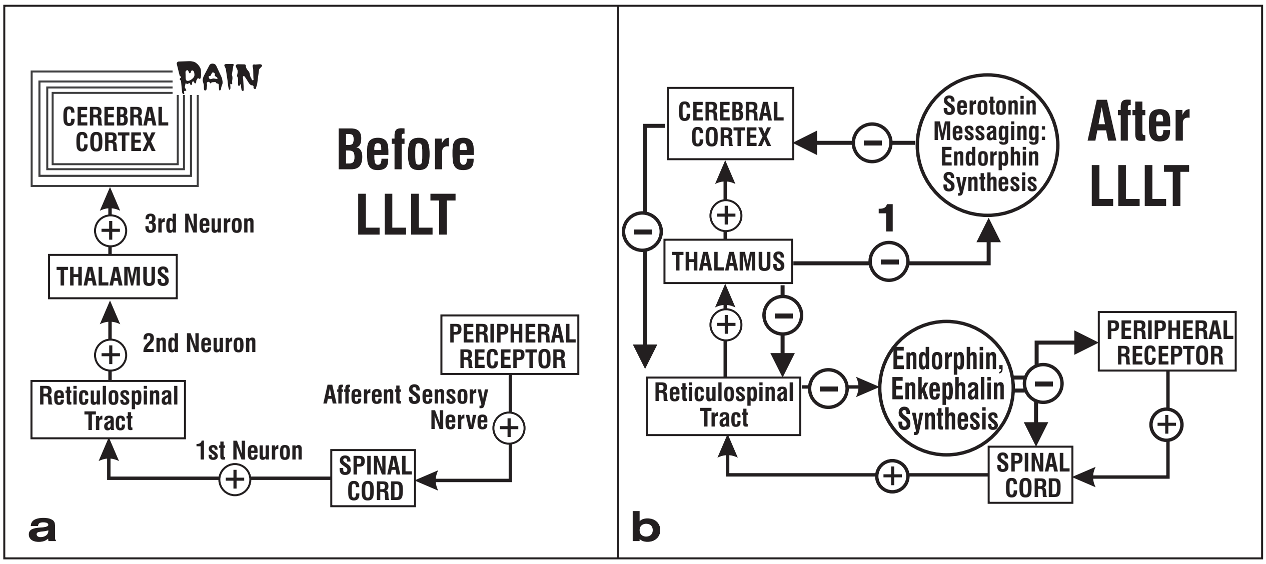

Fig 7: A schematic illustrating the pain transmission processes before (left) and after (right) LLLT. Following LLLT in the proximal priority method, serotonin messaging ordered by the activated cerebellum signals endorphin synthesis in the upper CNS, and the activated lateral reticulospinal tract signals endorphin synthesis in the lower part of the CNS, and endorphin followed by enkephalin synthesis in the periphery.

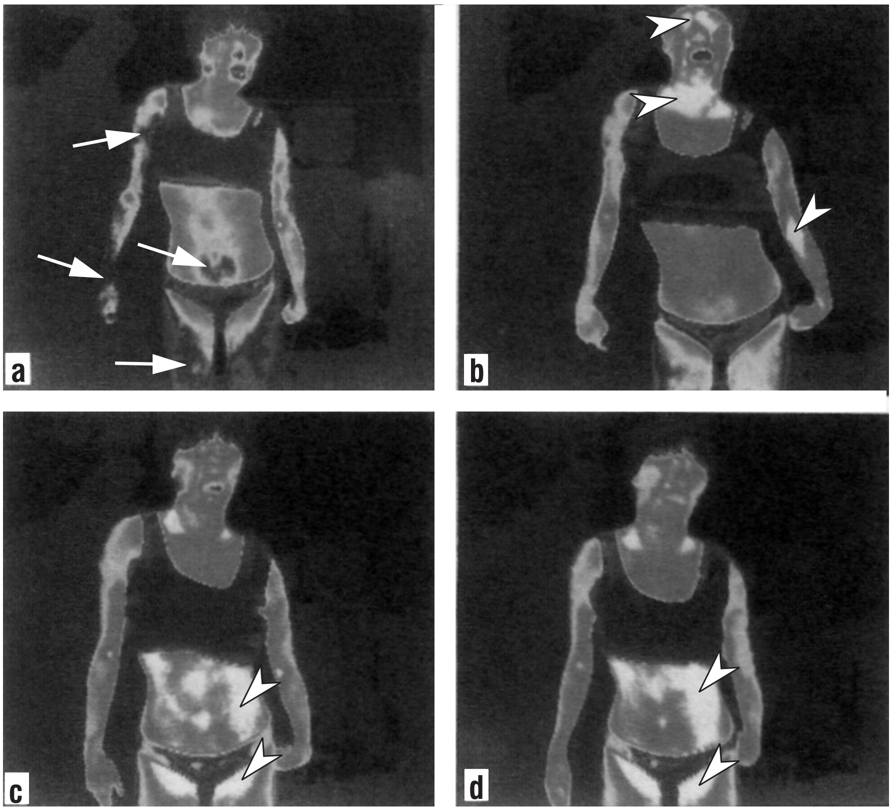

Fig 8: Total body warming following 830 nm proximal priority LLLT in a 23 year old female cerebral palsy patient. **a:** Before LLLT, thermography shows 'cold' extremities and abdomen. The white arrows indicate areas of extremely low temperature. **b:** 30 minutes after LLLT, warming is apparent. Arrowheads indicate areas of high temperature.**c:** 60 minutes after LLLT, the warming effect increases. Arrowheads indicate areas of high temperature: **d:** 90 minutes after LLLT, the latency of the treatment effect is still apparent and still increasing. Arrowheads indicate areas of high temperature. *(Adapted from Ref 19, Asagai Y, Ueno R, Miura Y, and Ohshiro T [1995]: Application of low reactive-level laser therapy (LLLT) in patients with cerebral palsy of the adult tension athetosis type.* Laser Therapy*, 7: 113-118, used with permission)*.

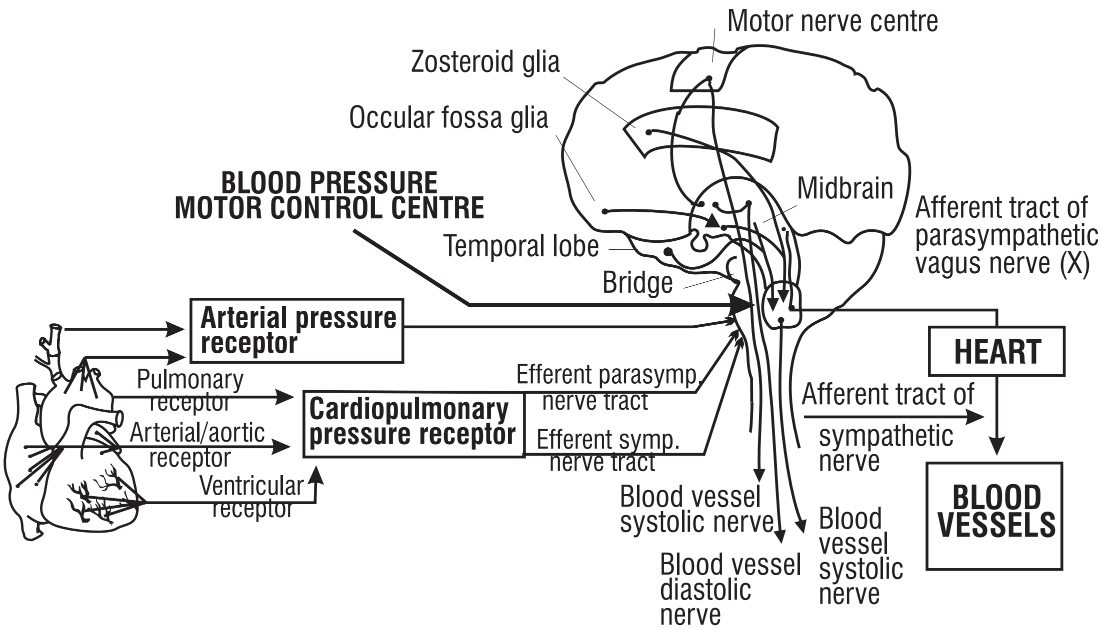

Fig 9: The pathways of the blood pressure control center illustrated diagramatically. *(Reprinted from Ref 22, Umeda T, [1990]: Blood pressure controlled by low reactive level diode laser therapy (LLLT).* Laser Therapy*, **2:** 59-64, used with permission).*

controlled study, and the photoactivation of the blood pressure control center is believed to be at the heart of the mechanism as seen in Figure 9, used with permission from the 1990 report by Umeda.[22] In the same trial, interestingly, some of the subjects in the normotensive group were actually hypotensive, and their blood pressures rose towards a more normal level. Sasaki *et al.* reported on the use of LLLT to restore pigment to vitiliginous areas,[23] and others have reported on the opposite use, to remove areas of hyperpigmentation either as a secondary side effect to some cutaneous injury, as a transient hormonally mediated pigmentation, or in mild cases of melanin anomaly group naevi.[1] This 'balancing' or 'normalizing' effect of LLLT is most important to understand and is at the heart of the non-pain applications of LLLT including hypertrophic and depressive scar revision in addition to the ones mentioned above. Even in the treatment of pain, LLLT is also able in many instances to restore feeling to numbed areas in addition to removing pain, in addition to the restoration of damaged neural functions and control of hyper-excited neurons.[24-27]

Conclusions

In my opinion, the proximal priority technique adds a great deal of anatomical sense to laser therapy when LLLT is applied on an anatomical basis, and it has worked very well for me in over 48,000 patients treated with laser therapy. To paraphrase the words of the pioneering laser neurosurgeon, Peter Ascher; "The Proximal Priority Technique will not necessarily turn a poor laser therapist into a good one, but it will definitely turn a good laser therapist into a better one."

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