



Physiotherapy Techniques in Augmenting Bone Healing using LLLT Across Fracture Gaps

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Abstract

Traditional Biomechanics studies have in the past years, are of the opinion that fracturing gaps, however stable need to be less than 1.5 - 2 mm wide for bone healing to occur. With the advent of Low-level Laser Therapy [LLLT], the upper limit is now modified as ≤ 4 mm, and the clinical implication is that more fractured patients will benefit from conservative treatment with splints and LLLT rather than subjected to open surgery.

Keywords: Low-Level Laser Therapy (LLLT); Bone Healing; Fracture Healing; Physiotherapy; Photo biomodulation; Bone Regeneration; Callus Formation; Bone Morphogenetic Protein

Introduction

To most surgeons and orthopedic surgeons alike, we are used to the traditional textbook teaching in Orthopedics' involve open reduction rigid fixation by operation as proposed by the Swiss AO group which proposes the fracture should be healed by so-called direct bone healing as depicted in manual of AO internal fixation techniques. However, soon it was realized that direct bone healing results in not so strong new bones. As such, the Swiss AO group later amended their stance to more biological plating and less trauma to the nearby soft tissue envelope, with the realization that firstly we should pay close attention to the soft tissue envelope since many cells in the fracture hematoma are conducive to bony healing; and preservation of a relatively intact soft tissue envelope preserve adequate blood flow needed for proper fracture healing [1].

It should be noted that in real life many fractures heal by so-called indirect healing i.e. not in the presence of rigid fixation. In fact, the so-called indirect healing is the healing

chosen by nature and the new bone formed called callus are often stronger than new bony union achieved by direct bone healing. The previous old textbook literature claims that indirect healing can only occur if the fracture gap is ≤ 1.5 mm or at most 2 mm; if the gap is bigger, it stands the chance of delayed or nonunion [2]. This means if the gap is greater than 2 mm many a surgeon may proceed to an operative solution.

Low-Level Laser Therapy [LLLT] is a totally non-invasive treatment modality. It has bio modulation action and acts on the cellular molecular level by increasing the energy level of the injured body cells, increased blood supply by the nitric oxide pathway, also causes gene activation to produce more BMP or bone morphogenetic protein; it further remodel the bone ends by its action of both the osteoblasts and osteoclasts cells [3]. Figure 1 shows the use of LLLT in treating a displaced transverse fracture patella, notice LLLT caused bridging new bone callus across a much larger fracture gap of 3.5 mm to 4 mm. The displaced fracture patella went on to heal without plaster or rigid open fixation by surgery, just

being given a soft splint in initial 3 weeks. It can be seen that in the presence of LLLT the acceptable fracture gap before solid bone union can occur has now been increased to 3-4 mm, double the gap as reported in the world literature, thus many a patient can be spared the ordeal of going through open surgery and later a 2nd subsequent surgery to remove the metallic implants Figure 1.



Figure 1: Displaced Transverse Fracture Patella with Intact Extensor Mechanism Healed with LLLT despite a Fracture Gap nearly 4 mm in length.

So, what are the points to note in practice as a physiotherapist to enhance bony union using LLLT. These include:

- proper selection of patients: the chance of LLLT induced bony union is improved in younger patients as they have higher metabolic rate, that does not mean LLLT cannot be used to treat fractures in older people, but the process may take longer.
- proper knowledge of anatomy: since we are concentrating or focusing on the laser light onto the fracture site, thus one should know the exact location of the fracture, as far as anatomy is concerned, we should be aware of the vascular supply of the broken bone. Those cases with intact soft tissue envelope, i.e. not open fracture, are essential conditions for LLLT to be successful.
- proper LLLT settings: The author had performed 80000 LLLT treatments: the machine used were GaAlAs semiconductor laser device with 5.4 J per point and a power density 20 mW/cm². For fresh fractures, treatment at least 2-3 times per week is advisable, the treatment time varies but usually from 120 to 180 seconds. Total length of time required varies, usually children heal much faster than elderly.

Conclusion

In conclusion, LLLT allows more patients with fresh fractures to benefit from conservative treatments. As they are usually given a splint, they also do not need to carry a heavy plaster cast that can cause stiffness of nearby joints after removal.

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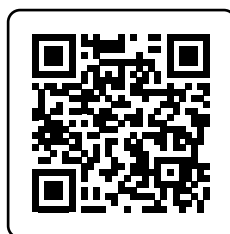
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