

Analgesic Effect of High Intensity Laser Therapy in Knee Osteoarthritis

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ABSTRACT

Knee osteoarthritis (KOA), the most common type of osteoarthritis (OA), is associated with pain and inflammation of the joint capsule, impaired muscular stabilization, reduced range of motion and functional disability. High-intensity laser therapy (HILT) involves higher-intensity laser radiation and causes minor and slow light absorption by chromophores. Light stimulation of the deep structures, due to high intensity laser therapy, activates cell metabolism through photochemical effect. The transmissions of pain stimulus are slowed down and result in a quick achievement of pain relief. The aim of our research was to investigate the prompt analgesic effect of HILT on patients with KOA. Knee radiographs were performed on all patients and consequently graded using the Kellgren-Lawrence grading scale (K/L). A group of 96 patients (75 female, 21 male, mean age 59.2) with K/L 2 and 3 were submitted to HILT therapy. Pain intensity was evaluated with visual analogue scale (VAS) before and after the treatment. HILT consisted in one daily application, over a period of ten days, using protocol wavelength, frequency and duration. The results showed statistically significant decrease in VAS after the treatment ($p < 0.001$). Considering these results, HILT enables prompt analgesic effects in KOA treatment. Therefore HILT is a reliable option in KOA physical therapy.

Key words: knee osteoarthritis, laser therapy, analgesia

Introduction

Knee osteoarthritis (KOA) is the most common form of osteoarthritis that affects the elderly. It is a leading cause of disability and has a formidable societal and public health impact^{1,2}. One third of people aged 65 years and older have KOA, which is evident by radiography. Before the age of 50, men are more likely to have osteoarthritis (OA) than women, but after age 50 women are statistically more likely to be affected³. Pain is the cardinal symptom of OA and is the major determinant of disability and functional impairment in people with OA⁴. Knee pain is often associated with osteophytes formation, but a widespread belief exists that there is a high discordance between clinical and radiographic KOA^{5,6}. Limitation of joint motion is usually related to osteophyte formation, severe cartilage loss or periarticular muscle spasm and contracture. Periarticular muscle weakness is common and may contribute to progression of KOA through decreased neuromuscular protective mechanisms and functional joint instability³.

Laser therapy is based on the belief that laser radiation (and possibly monochromatic light in general) is able to alter cellular and tissue functions in a manner that is dependent on the characteristics of the light itself (e.g., wavelength, coherence)⁷. The first source of laser was established in 1960. by T.H. Maiman. In the seventies, laser started being successfully used, first in surgery and afterwards as a healing method and as a consequence the term laser therapy has been introduced. More recently, high-intensity laser therapy (HILT), which involves higher-intensity laser radiation and which causes minor and slow light absorption by chromophores, has been used. This absorption is obtained not with concentrated light but with diffuse light in all directions (the scattering phenomenon), increasing the mitochondrial oxidative reaction and adenosine triphosphate, RNA, or DNA production (photochemistry effects) and resulting in the phenomenon of tissue stimulation (photobiology

effects). The analgesic effect of HILT is based on different mechanisms of action, such as slowing down the transmission of pain stimulus and increasing the production of morphine-mimetic substances⁸.

In this paper we investigate the prompt analgesic effect of HILT in our group of patients with moderate KOA.

Patients and Methods

Our investigation was conducted on a group of 96 patients, 75 females and 21 males, aged from 56 to 66 years, with a mean age of 59.2. The patients were submitted previously to x-ray of the affected knee and consequently the grade of KOA was determined using the Kellgren-Lawrence grading scale⁹ (Table 1). Our group of patients had K/L 2 and 3 grade of KOA. All the patients in the present study were evaluated applying a visual analogue scale (VAS)¹⁰. The VAS is used to measure pain on a 100 mm horizontal axis between the extreme left endpoint of no knee pain and the extreme right endpoint of worst pain ever. The distance is measured, and pain is recorded on a 100-point scale¹⁰. In the pain setting, the VAS has been shown to have very good test-retest reliability (intraclass correlation coefficient – ICC=0.99)¹¹. This scale generally is accepted as a valid measure of pain, with good construct validity^{12,13}. Therefore, the pain level was evaluated by using the visual analogue scale (VAS) before and following the whole HILT treatment which was performed with Neodymium YAG pulse wave (Nd:YAG PW) device (ASA HIRO 3.0®, USA,). We used the wavelength of 1064 nm, peak power to 3 kW and pulse duration <120µs. Therapy lasted 20 min daily, for 10 consecutive days, following the specified treatment protocol.

Statistical analysis

A Student's *t*-test was performed to determine significant differences between dependent samples of previously mentioned group before and after the HILT treatment ($p < 0.001$ was used as the cut-off value for significance). Furthermore, formula for quantitative comparison was used in measuring the percentage of pain decrease after the HILT treatment ($\text{VAS change} = \text{VAS before} - \text{VAS after} / \text{VAS before} \times 100\%$).

TABLE 1
KELLGREN-LAWRENCE GRADING SCALE

Grade 1	Doubtful narrowing of joint space and possible osteophytic lipping
Grade 2	Definite osteophytes, definite narrowing of joint space
Grade 3	Moderate multiple osteophytes, definite narrowing of joints space, some sclerosis and possible deformity of bone contour
Grade 4	Large osteophytes, marked narrowing of joint space, severe sclerosis and definite deformity of bone contour

Results

The pain level before HILT expressed by VAS was between 45 and 70 mm, mean value 57 mm. After the HILT treatment VAS of pain was decreased, its value was between 10 and 30 mm, mean value 22 mm ($p < 0.001$). Furthermore, VAS median value after the treatment was statistically significant, decreasing from 50 to 20 mm (*t*-test for dependent samples, $t = 26.5$, $p < 0.001$). Using the formula for quantitative comparison ($\text{VAS change} = \text{VAS before} - \text{VAS after} / \text{VAS before} \times 100\%$), the result was $63 \pm 25\%$ of pain decrease after the HILT treatment, which was statistically significant at the level $p < 0.001$, (Figure 1).

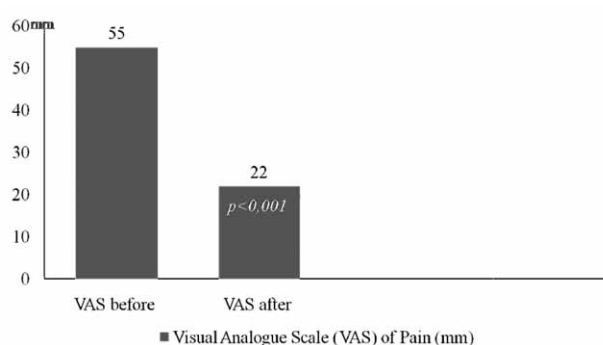


Fig. 1. Visual analogue scale (VAS) of pain before and after treatment, statistically significant decrease ($p < 0.001$)

Discussion and Conclusion

HILT quickly reduces inflammation and painful symptoms¹⁴. It utilizes a particular waveform with regular peaks of elevated values of amplitude and distances (in time) between them to decrease thermal accumulation phenomena, and it is able to rapidly induce in the deep tissue photochemical and photothermic effects that increase blood flow, vascular permeability and cell metabolism¹⁵. The HILT had an analgesic effect on nerve endings but there was no evidence of a diminution of inflammation^{16,17}. In particular, Santamanto and colleagues found greater effectiveness of HILT than of therapeutic ultrasound in the treatment of shoulder subacromial impingement¹⁸.

However, to our knowledge, to date very few studies have been conducted on the possible effects of HILT on KOA. In the present study, the results were obtained after 10 HILT treatment sessions over a period of 2 consecutive weeks in patients diagnosed with KOA, K/L grade 2 and 3. The patients treated with HILT showed a great and statistically significant reduction in pain. Therefore, HILT demonstrates to have a very good and quick analgesic effect in patients with KOA. Furthermore there were no adverse events between patients during or after the treatment. Limitations of this preliminary study include the lack of control group receiving no treatment or the group treating with another physical modality. This

limitation constrains our ability to claim the cause and effect. Patients may have improved simply because of the passage of time, because of the avoidance of painful activity for the treatment period or because of the equally effective analgesia produced by some other accepted physical therapy modality. Another limitation is the lack of follow-up data, which reduces the clinical application of our findings on the short-term effects of HILT. Furthermore, our protocol of 10 treatment sessions over a period of two weeks could be challenging to apply in clinical practise because of the high percentage of pain decrease

after the conducted HILT therapy. The results of the present study are encouraging but other studies with larger samples, long term findings and possible comparisons with other conservative interventions or placebo control groups are needed. For this reason prospective studies of the HILT efficacy should be conducted especially in functional and muscle strength improvement because of painless range of movement and on beneficial effects on cartilage regeneration. Finally, continued research in this area is therefore of great importance.

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ANALGETSKI UČINAK TERAPIJE LASEROM VISOKOG INTENZITETA U OSTEOARTRITISU KOLJENA

SAŽETAK

Osteoarthritis koljena (KOA), najčešći oblik osteoartritisa (OA), karakteriziran je pojavom boli, upalom zglobne čahure, oštećenjem mišićne stabilnosti, smanjenjem opsega pokreta i funkcijskom onesposobljenošću^{1,2}. Terapija laserom visokog intenziteta (HILT) uključuje više razine laserskog zračenja čime izaziva smanjenu i usporenu apsorpciju svjetlosti putem kromofora. Svjetlosna stimulacija dubokih tkiva, putem laserske terapije visokog intenziteta, potiče stanični metabolizam fotokemijskim učinkom. Prijenos bolnih stimulusa je usporen što se očituje u brzom ublažavanju boli⁸. Cilj našeg istraživanja je ustanoviti promptni analgetički učinak HILT-a u bolesnika s KOA. Svi bolesnici podvrgnuti su radiološkoj analizi koljena u svrhu stupnjeva oštećenja pomoću Kellgren-Lawrence skale za stupnjevanje (K/L). Grupa od 96 bolesnika (75 žena, 21 muškarac, srednje životne dobi 59,2) sa stupnjem osteoartritisa koljena K/L 2 i 3 tretirana je HILT-om. Intenzitet boli vrednovan je pomoću vizualne analogne skale (VAS) prije i poslije tretmana. HILT je primijenjen jednom dnevno, tijekom 10 dana, koristeći valnu dužinu, frekvenciju i trajanje prema protokolu. Rezultati pokazuju statistički značajno smanjenje VAS-a nakon terapije ($p < 0,001$). Obzirom na rezultate HILT omogućuje promptni analgetski učinak u liječenju KOA. Zbog toga je HILT pouzdana opcija u fizikalnoj terapiji KOA.