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ORIGINAL ARTICLES

Low Level Laser Therapy for chronic knee joint pain patients

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Background and Aims: Chronic knee joint pain is one of the most frequent complaints which is seen in the outpatient clinic in our medical institute. In previous studies we have reported the benefits of low level laser therapy (LLLT) for chronic pain in the shoulder joints, elbow, hand, finger and the lower back. The present study is a report on the effects of LLLT for chronic knee joint pain.
Materials and Methods: Over the past 5 years, 35 subjects visited the outpatient clinic with complaints of chronic knee joint pain caused by the knee osteoarthritis-induced degenerative meniscal tear. They received low level laser therapy. A 1000 mW semi-conductor laser device was used to deliver 20.1 J/cm² per point in continuous wave at 830nm, and four points were irradiated per session (1 treatment) twice a week for 4 weeks.
Results: A visual analogue scale (VAS) was used to determine the effects of LLLT for the chronic pain and after the end of the treatment regimen a significant improvement was observed ($p<0.001$). After treatment, no significant differences were observed in the knee joint range of motion. Discussions with the patients revealed that it was important for them to learn how to avoid postures that would cause them knee pain in everyday life in order to have continuous benefits from the treatment.
Conclusion: The present study demonstrated that 830 nm LLLT was an effective form of treatment for chronic knee pain caused by knee osteoarthritis. Patients were advised to undertake training involving gentle flexion and extension of the knee.

Key words: Low Level Laser Therapy · knee osteoarthritis · chronic knee joint pain, meniscal tear · posture education · activities of daily living

Introduction

Chronic knee pain is one of the most frequent complaints which we experience in the out-patients clinic in our hospital. We define chronic pain in this report as "pain which has lasted for 6 months or more, inflammation, trauma or a tumor can be excluded by medical check-ups, and the cause of pain is not something that requires surgery". Chronic pain can be very debilitating, and decreases the patients' Activity of Daily Living (ADL) and Quality of Life (QOL). Very often patients are required to reduce their social, and occupational actives as well. This study was designed to assess the effect on knee pain of Low Level Laser Therapy (LLLT), plus patient education regarding lifestyle guidance.

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Subjects and Methods

1: Subjects

Thirty-five patients (5 males and 30 females) between the age of 53 and 93 (average age76.6yr) took part in this study. All subjects were out-patients who visited the rehabilitation department of our hospital between April, 2008 and March, 2013 **(Table 1)**. They all had a definitive diagnosis of knee osteoarthritis (of moderate degree without surgical indication).

Diagnosis of the disease was based on physical symptoms, X-ray findings, and magnetic resonance imaging (MRI).

Table 1: Outline of Cases

Case	Sex	Age	VAS		Evaluation(Table:3)
			Before	After	E
1:	F	70	85	50	G
2:	F	82	70	50	G
3:	F	79	85	55	G
4;	M	64	70	40	G
5:	F	60	70	45	G
6:	M	79	75	45	G
7:	F	83	55	40	F
8:	F	84	60	35	G
9:	F	74	85	65	G
10:	F	79	75	30	E
11:	F	84	50	40	N
12:	F	83	70	60	N
13:	F	79	80	65	F
14:	F	71	50	20	G
15:	M	73	70	55	F
16:	F	86	90	75	F
17:	F	68	60	20	E
18:	F	74	70	60	N
19:	F	60	50	25	G
20:	F	85	65	50	F
21:	F	53	70	50	G
22:	F	93	70	60	N
23:	M	88	65	40	G
24:	F	80	80	35	E
25:	F	88	75	55	G
26:	F	64	50	40	N
27:	M	82	70	30	E
28:	F	66	65	50	F
29:	F	75	60	35	G
30:	F	85	65	55	N
31:	F	76	70	45	G
32:	F	81	70	50	G
33:	F	75	85	70	F
34:	F	82	75	55	G
35:	F	75	50	40	N

2: Methods

We used a 1000 mW semiconductor laser device, the MDL 2001 (Matsushita Electric Corporation, Tokyo, Japan) **(Figure 1)** delivering 830nm in continuous wave. We treated the chronic knee joint pain for the affected knee joints with the laser therapy system for each session at an energy density per 30 sec treatment of 20.1 J/cm² **(Table 2)**. Four points were irradiated

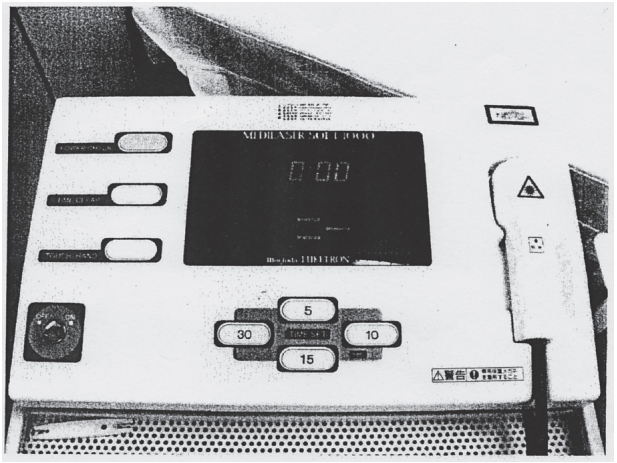

Figure 1: The appearance of the Low Level Laser Therapy device

Table 2: Low Level Laser Therapy device Specifications

Laser Element	Semiconductor Laser Diode
	Ga-Al-AS: Gallium-Aluminum-arsenide
Model &	MDL-2001 model
Manufacturer	Matsushita Electric Corporation, Tokyo, Japan
Wavelength	830nm±15nm
Output	1000mW±20%
Mode	continuous wave mode
	contact mode with positive pressure
Irradiation area	diameter of 14mm : actual area 1.5 cm²
Irradiation time	30sec/point
Energy density	20.1 J/cm²/point
Power supply	100VAC,50-60Hz

(Figure 2) per session (comprising 1 treatment) twice a week for 4 weeks. A schematic illustration is shown in **Figure3a-b**.

Evaluation of pain and knee joint range of motion:

Pain was assessed after the treatment session using a Visual Analogue Scale **(Table 3)**. After treatment, knee joint flexion and extension mobility levels were measured to assess any changes in the range of motion (ROM) of the joint.

Lifestyle guidance for the patients:

Patients were advised to continue their normal living style. We give them written advice sheets on maintaining a good posture, to avoid sitting in the Japanese fashion, to steer clear of torsion of the knee, to perform gentle flexion and extension of knee joint, and so on.

Statistical Analysis:

VAS was measured before treatment started (baseline) and after the final full 8 sessions of LLLT, and these

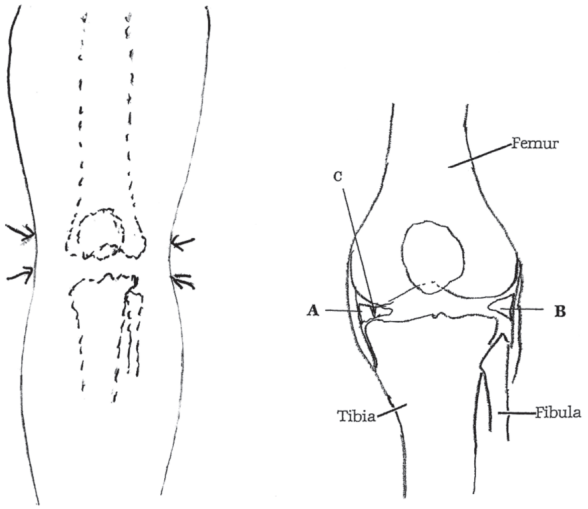

Figure 2: Schematic illustration of knee joint (arrows in the left-hand diagram illustrate LLLT treatment points)
A: Medial semilunar cartilage (meniscus)
B: Lateral semilunar cartilage (meniscus)
C: Tear in the meniscus

Table 3: Visual Analogue Scale(VAS)
The score is 100 when the pain is the most severe.
The score is 0 when there is no pain.

Evaluation	Improvement in pain Score after LLLT Irradiation	Number of Cases
・Excellent(E)	35 and over	5
・Good(G)	20-34	16
・Fair(F)	15-19	7
・No change(N)	14 or under	7
・Worse/Side effect		0

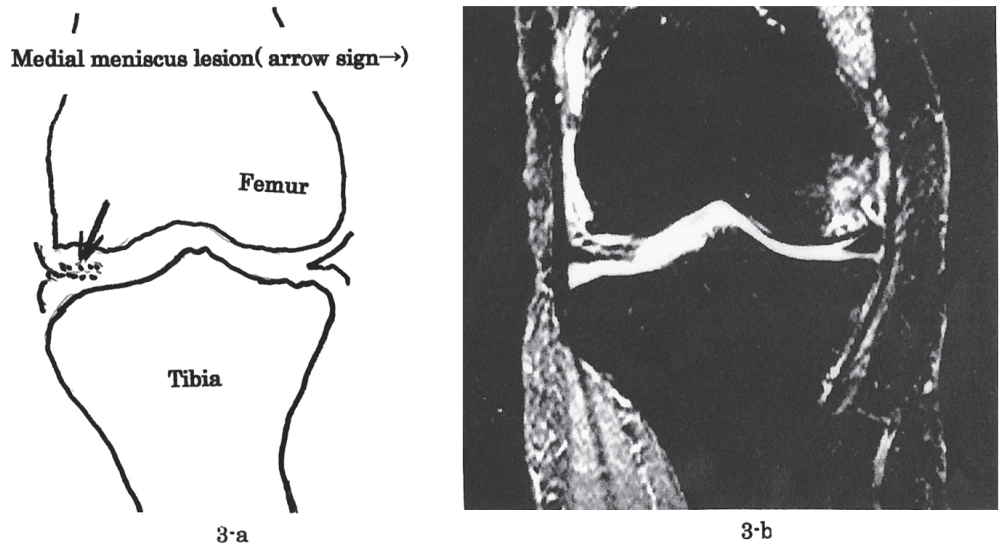

Figure 3-a: Schematic illustration of a meniscal lesion.
3-b: Typical example of the MRI (T2) findings, showing the frontal plane of the meniscal lesion.

two sets of scores were averaged and compared. All values were expressed as the means±standard deviation. Comparisons of values were performed with the Wilcoxon signed rank test (nonparametric score), using SPSS Statistics Ver.17.OJ, with a value of less than 5% considered significant. The study was conducted under the principles of the Declaration of Helsinki (2004). The trail was conducted with the approval of the Ethics Committee of the Toho University School of Medicine, Institutional Review Board (IRB). The purpose and potential outcomes of the trial were explained to all participants, and they gave written informed consent to participate the study.

Results

Pain Evaluation:

The VAS scores at baseline and at the final assessment are shown in **Table 3**. The E (excellent) group comprised 5 subjects with an average effect latency of 48.0 hours; the G (good) group comprised 16 subjects with an average effect latency of 28.8 hours; there were 7 subjects in the F (fair) group with an average effect latency of 26.6 hours; 7 subjects were in the N (little or no change) group with an average effect latency of 13.1 hours; and no subjects were in the W (worse) group. No side effects were found. The average VAS scores before treatment were 68.7±11.1 (mean±SD) and after treatment the average VAS was 46.7±13.4 (mean±SD). A significant improvement was observed ($p<0.001$).

Knee Joint Mobility:

Knee joint extension and flexion were measured, but no significant differences were observed after LLLT treatment (data not shown).

Patient Lifestyle Guidance:

Patients were advised to avoid postures that induce pain, and we advised the patients how to avoid incorrect positions in their Activities of Daily Living (ADL) as already mentioned in the Materials and Methods. After discussions with the patients, it was reported in all cases that the lifestyle guidance was well understood, and the advice that was given was fairly well complied with. However, in the score-sheet filled out by patients after the treatment, there were many subjects who did not precisely follow the lifestyle guidelines, therefore statistical analysis was not performed on this parameter.

Discussion

The human body is a complex mechanical unit composed of many joints held together by muscles, tendons and cartilages which also allow articulation. Gravitational forces must be balanced at all times at each link.

The line of gravity, one of the body's most important factors as described by Harada, passes through the outer ear-opening and intersects the center of the gravity of the human body (located adjacent to the sacrum) and the center of the knee joint [1].

The understanding of the function of the locomotive apparatus in the upright position and the dynamics of the body is one of the most important factors, so that the gravitational torque has a tendency to extend the knee joints in our daily life.

In many cases knee osteoarthritis at a moderate stage is caused by a tear in the meniscus induced by degenerative changes of the knee joint cartilages. Generally, we treat the disease with medication, bracing [2], education of life style, physical therapy, and surgery. In this study, we treated the disease with LLLT irradiation, as one of the aspects of physical therapy. LLLT is simple and easy to administer without any side effects. Regarding the evaluation of pain, statistically significant effects were observed in the VAS scores after irradiation ($p<0.0001$). However, there was no significant change in knee joint range of motion after LLLT treatment.

There has been a lot of basic research [3, 4, 5, 6, 7] and many clinical studies [8, 9, 10, 11] carried out on LLLT. Some previous reports discuss the type of LLLT device [12], wavelength-specific benefits [13] and evaluation of treatment methods. Recently, basic research on LLLT is gaining validity. There are various possible explanations for the positive effects of LLLT treatment. The authors believe that a rise in the pain threshold, improved blood flow and regeneration of knee cartilage are the main contributing factors [14, 15, 16]. We believe that the number of subjects was large enough to show an accurate trend with reasonable statistical significance. However, one limitation of this cross-sectional study was the lack of a demographically-matched control and/or placebo (sham irradiation) group.

Another limitation is the lack of a long-term follow-up after the final treatment session to assess the latency of the efficacy. To validate the results of this study, such controlled and placebo studies with a long-term follow-up are required and warranted in the future.

Conclusion

Our results in the present study confirmed that 830 nm diode laser LLLT was an effective treatment for pain related to knee osteoarthritis. Moreover, for patients to continue to reap the benefits of LLLT treatment, we discovered that education regarding the patient's posture during their ADL was also very important.

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