CLINICAL SCIENCE

COMPARISON OF THE EFFECTS OF HIGH-INTENSITY LASER WITH LOW-INTENSITY LASER IN PATIENTS WITH KNEE OSTEOARTHRITIS

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Key words: high-intensity laser, low-intensity laser, knee osteoarthritis, WOMAC index

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Abstract

Knee osteoarthritis is a musculoskeletal disease characterized by degeneration and deterioration of articular cartilage. In addition to pharmacological therapy, physical modalities including low-intensity laser therapy (LILT) and high-intensity laser therapy (HILT), and kinesitherapy are used to treat knee osteoarthritis (KOA). To date, no research has been conducted in the Republic of North Macedonia that could be compared to existing research about the effects of HILT and LILT on functional ability in patients with KOA. The aim of this study was to compare the treatment effects of HILT and LILT in patients with KOA. Materials and methods: This was a randomized comparative single-blind study involving 72 patients divided into two groups. The first group was treated with 10 sessions of HILT, and the second group with 10 sessions of LILT. Patients of both groups performed exercises for 1 month. Functional outcome was evaluated after the end of the laser therapy and after 1 month using the Western Ontario and McMaster Universities Osteoarthritic Index (WOMAC). Statistical significance was defined as $p<0.05$. Results: At the end of the laser therapy and 1 month later, a statistically significant difference was found between the two groups, measured by the WOMAC index ($p<0.001$). Additionally, the WOMAC index was compared within the groups. Conclusion: Patients with KOA who were treated with HILT had significantly better functional recovery than patients treated with LILT.

КЛИНИЧКИ ИСТРАЖУВАЊА

СПОРЕДБА НА ЕФЕКТИТЕ ОД ЛАСЕР СО ВИСОК ИНТЕНЗИТЕТ И ЛАСЕР СО НИЗОК ИНТЕНЗИТЕТ КАЈ ПАЦИЕНТИ СО ОСТЕОАРТРИТИС НА КОЛЕНОТО

Валентина Коевска[1], Ериета Николиќ-Димитрова[1], Билјана Митревска[1], Цветанка Ѓеракароска-Савевска[1], Марија Гоцевска[1], Билјана Калчовска[1], Маја Манолева[1], Даниела Гечевска[1]

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Клучни зборови: високоинтензивен ласер, нискоинтензивен ласер, остеоартритис на колено, WOMAC индекс.

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Печатарски права: ©2025. Валентина Коевска, Ериета Николиќ-Димитрова, Билјана Митревска, Цветанка Ѓеракароска-Савевска, Марија Гоцевска, Билјана Калчовска, Маја Манолева, Даниела Гечевска. Оваа статија е со отворен пристап дистрибуирана под условите на нелокализирана лиценца, која овозможува неограничена употреба, дистрибуција и репродукција на било кој медиум, доколку се цитираа ториганалниот(ите) автор(и) и изворот.

Конкурентски интереси: Авторот изјавува дека нема конкурентски интереси.

Извадок

Остеоартритисот на коленото е мускулно-скелетно заболување кое се карактеризира со дегенерација и влошување на зглобната ,рскавица. Покрај фармаколошката терапија, конвенционалните физикалните модалитети и кинезитерапија, во лекување на остеоартритис на коленото (ОАК) последниве неколку години се користи високоинтензивен ласер (ВИЛ) и нискоинтензивен ласер (НИЛ). Во нашата земја се уште немаше спроведено истражување каде е споредена ефектот на ВИЛ и НИЛ. Цел на трудот е да се спореди терапискиот ефект на ВИЛ со НИЛ во третманот на ОА на коленото. Материјал и методи: Рандомизирана компаративна едностранослепа студија која вклучува 72 пациенти поделени во две групи. Првата група се лекува со ВИЛ, втората група се лекува со НИЛ. Пациентите од двете групи изведуваа вежби во текот на 1 месец. Функционалниот исход беше оценет по завршувањето на ласерската терапија и по 1 месец со користење на остеоартритичниот индекс на универзитетите Западен Онтарио и Мекмастер (WOMAC). Статистичката значајност беше дефинирана како $p <0,05$. Резултати: На крајот од ласерската терапија и 1 месец подоцна, беше утврдена статистички значајна разлика помеѓу двете групи, мерена со WOMAC индексот ($p <0,001$). Дополнително, WOMAC индексот беше споредена во рамките на групите. Заклучок: Пациентите со КОА кои биле третирани со ВИЛ имале значително подобро функционално закрепнување од пациентите третирани со НИЛ.

Introduction

Osteoarthritis (OA) is a very common cause of chronic musculoskeletal pain and disability in the adult population. In fact, all people over 60 years have some degenerative changes in their joints; 70-85% of them have signs and symptoms such as pain and short-term morning stiffness. One of the most common forms of osteoarthritis found in clinical practice is knee osteoarthritis (KOA). Radiographic evidence of KOA is present in about 30% of men and women over the age of 65[1].

Knee osteoarthritis is characterized by degeneration and disintegration of the cartilage of the joint which over time leads to narrowing of the joint space. The ligaments and surrounding tendons may be affected. Pain, morning stiffness, and limited knee mobility are characteristic symptoms of OAK. Pain occurs due to changes in the synovial membrane, mechanical irritation from osteophytes, and extraarticular structures of the knee such as bursitis, tendinitis, tendinopathy, and etc. Pain and functional limitations lead to a reduction in quality of life and reduced participation in social activities[2].

Analgesics, nonsteroidal anti-rheumatic drugs, glucosamine sulfate, chondroitin sulfate, and regular exercising are recommended to reduce pain and improve functional ability[3]. So far, several physical modalities such as interference currents, diadynamic currents, laser treatment, therapeutic ultrasound, aquatic therapy, extracorporeal shockwave therapy, and pulsed electromagnetic field therapy have been shown to be effective in treating OAK pain[4, 5].

Several recent studies have shown that low-intensity laser therapy (LILT) reduces pain, stiffness and functional limitations in patients with OAK 6, 7. LILT has a biostimulatory effect, accelerates the regeneration of damaged and diseased tissues, reduces swelling and pain, and has an anti-inflammatory effect[7]. The advantage of these lasers is their minimal thermal effect. High-intensity laser (HILT) is a relatively new non-invasive physical modality in the treatment of OAK. The advantage of HILT is that by increasing power, the depth of penetration is increased, resulting in the augmented effects on deep structures. In tissues, HILT causes increased oxygenation in the mitochondria and formation of ATP, which leads to an increased absorption of edema by enhancing metabolism[8].

The HILT and LILT have been shown to have a biostimulative effect on cartilage, and surrounding muscle and ligament tissue in joints as well as a positive effect on pathoanatomical changes in OA. They also improve symptoms of the disease along with functioning. These effects were more pronounced when HILT was applied[9]. The results of several randomized trials investigating the effects of HILT treatment showed a significant reduction in pain and improvement in physical function in KOA[10,11,12,13].

So far, no comparative study of the impact of HILT and LILT on patients with knee OA has been conducted in North Macedonia. Therefore, we decided to initiate research in the local setting to evaluate the effects of this therapy, with the aim to implement a better and higher treatment quality in patients with KOA. The results of the research should help to

establish better treatment protocols for patients with KOA with physical therapy.

The aim of this study was to compare the treatment effects of HILT and LILT in patients with KOA.

Materials and methods

This single-blind randomized comparative study was conducted at the University Clinic for Physical Therapy and Rehabilitation in Skopje from January 2018 to March 2020. The study included 72 patients who had previously been diagnosed with KOA stage 1 and 2, based on X-ray.

Exclusion criteria were: application of corticosteroids and hyaluronic acid in the last 3 months, malignant diseases, fractures, tendon injury, meniscal injury, ligament injury, diseases of the hip and ankle, surgery of the knee, rheumatoid arthritis, diseases with contraindications for using laser therapy. Patients were randomly assigned in two groups.

Patients in group I were treated with high-intensity laser therapy, while patients in group 2 were treated with low-intensity laser therapy. For the high-intensity laser therapy, a VIKARE electro-medical device with 4W power was used. The treatment time per session was 10 minutes. The laser was applied by scanning transversally and longitudinally on the anterior, medial and lateral side of the knee joint with special emphasis on the femoral and tibial condyle. For the low-frequency laser treatment, an Eco Medico Laser device with 200mW power produced by Electronic Design was used. The total duration of one application was 8 minutes The patient lied in a supine position, with the knee flexed in 30º. Prior to application, the skin was cleansed with alcohol. The laser therapy was applied with a probe on the medial, anterior and lateral side of the knee, a total of 14 points. The patient and the doctor wore googles during the application of both LILT and HILT. Patients from both groups were treated daily, with a weekend break, receiving 10 sessions during a 2-week-period. In addition to laser therapy, patients of both groups performed strengthening and stretching exercises for knee and hip muscles every day for 30 minutes throughout the study period. Patients were evaluated before therapy, after 10 therapy sessions, and 1 month from the start of the therapy using the WOMAC index.

Assessment of physical function, stiffness, and knee pain was evaluated by the WOMAC index (Western Ontario and McMaster Universities Osteoarthritic Index). It consists of 24 items divided into three subscales: pain (5 items), stiffness (2 items), physical function (17 items). It can be used to monitor the course of the disease or to determine the effectiveness of various interventions (pharmacological, surgical, physiotherapy, etc.)[14].

The /study was approved by the Human Research Ethics Committee according to the Declaration of Helsinki, at the Faculty of Medicine, Ss. Cyril and Methodius University in Skopje, RN Macedonia and in compliance with the legal standards. Each patient was previously informed about the aims of the study, and signed an informed consent to participate. (No 03-2134/18)

The data obtained during the study was statistically processed using the SPSS Software Package, version 22.0 for Windows (SPSS, Chicago, IL, USA).

The analysis of the attributes (qualitative) series was done by determining the coefficient of relationships, proportions and rates, and they were shown as absolute and relative numbers. Numeric (quantitative) series were analyzed using central tendency measures (average, median, minimal values, maximum values, interactive rankings), as well as dispersion measures (standard deviation, standard error).

Pearson Chi Square Test, Fischer Exact Test and Fisher Feeman Halton Exact Test were used to determine the association between certain atrial dichotomic marks. Difference Test was used to compare the proportions.

Non-parametric tests for two independent specimens (Mann-Whitney U test) were used to test the significance of the difference between certain numerical parameters with improper frequency distribution. The analysis of two dependent numerical variables was made with Wilcoxon Signed Rank Test.

A level of P <0.05 was used to determine statistical significance.

Results

The mean age of patients in the HILT and LILT groups was 61.36 ± 8.14 vs. 60.36 ± 7.45 without a significant difference between the two groups (p = 0.71). Male patients were more prevalent in the group treated with HILT larger number of (p<0.05). No significant differences were found regarding mean age, number of patients in different age groups, and BMI (Table 1).

Table 1: General characteristics by groups

Parameters	groups		P
	HILT N=36	LILT N=36	
Gender N (%)			
Female	23 (63.89%)	31 (86.11%)	Pearson Chi-square test=4,74; df=1; p=0,0294*
Male	13 (36.11%)	5 (13.89%)	
Age(years)			
$\bar{X}$ ± **SD** **Min/Max** **Median (IQR)**	61.36±8.14 45/76 62 (55-68)	60.36±7.45 45/72 61 (55-66.5)	Mann-Whitney U Test: Z=0.37; p=0.71
Age groups - - N (%)			
40-49	2 (5.56%)	3 (8.33%)	Fisher-Freeman-Halton exact test: p=0.80
50-59	13 (36.11%)	14 (38.89%)	
60-69	13 (36.11%)	14 (38.89%)	
70-79	8 (22.22%)	5 (13.89%)	
BMI (kg/m²)			
$\bar{X}$ ± **SD** **Min/Max** **Median (IQR)**	30.68±4.49 22.25/40.40 30.24 (27.51-33.47)	30.29±4.49 22.55/40.40 29.38 (27.35-32.43)	Mann-Whitney U Test: Z=0.50; p=0.61

*Significant for p<0.05

The WOMAC subscales were analyzed at baseline, and after 10 therapy sessions. No significant baseline differences were found between the investigated groups (Table 2).

Table 2: Comparison of subscales from WOMAC between groups and within the group individually at two time points, 0 and 10 therapy sessions

WOMAC		N	X ± SD	Min/ Max	Median (IQR)	P
Pain						
0-time	HILT	36	14.39±3.31	9/20	15 (11-18)	[1]Z=0.99; p=0.32
	LILT	36	13.64±3.79	9/20	15 (10-16)	
10 therapies	HILT	36	4.44±2.28	1/10	4.5 (2.5-5.5)	[1]Z=-5.42; p=0.00001*
	LILT	36	8.28±2.46	4/15	8.5 (6-10)	
Wilcoxon signed rank test 0/10:				HILT - Z=5.21; p=0.00001* LILT - Z=5.06; p=0,00001*		
Stiffness						
0-time	HILT	36	6.36±1.42	3/8	7 (5.5-7.5)	[1]Z=0.03; p=0.96
	LILT	36	6.36±1.38	3/8	7 (6-7)	
10 therapies	HILT	36	1.50±0.94	0/4	1.5 (1-2)	[1]Z=-5.70; p=0.00001*
	LILT	36	3.55±1.31	0/6	4 (3-4.5)	
Wilcoxon signed rank test 0/10:				HILT - Z=5.23; p=0.00001* LILT - Z=5.15; p=0.00001*		
Function						
0-time	HILT	36	53.83±7.62	39/64	56 (47.5-60)	[1]Z=1.64; p=0.0001
	LILT	36	50.69±8.32	39/64	50 (43.5-58)	
10 therapies	HILT	36	24.50±9.78	9/38	24 (16-34)	[1]Z=-2.61; p=0.0088*
	LILT	36	30.94±6.61	16/44	32 (27-36)	
Wilcoxon signed rank test 0/10:				HILT - Z=5.23; p=0,00001* LILT - Z=5.23; p=0,00001*		
[1]Mann-Whitney U test				* significant for p<0.05		

Regarding pain, stiffness, and physical activity measured with the WOMAC subscales showed a significant reduction of all variables measured after 10 therapy sessions in both groups ($p<0.01$) (Figure 1). However, a significantly more pronounced effect regarding all analyzed variables was observed in the HILT group after 10 therapies (Table 2).

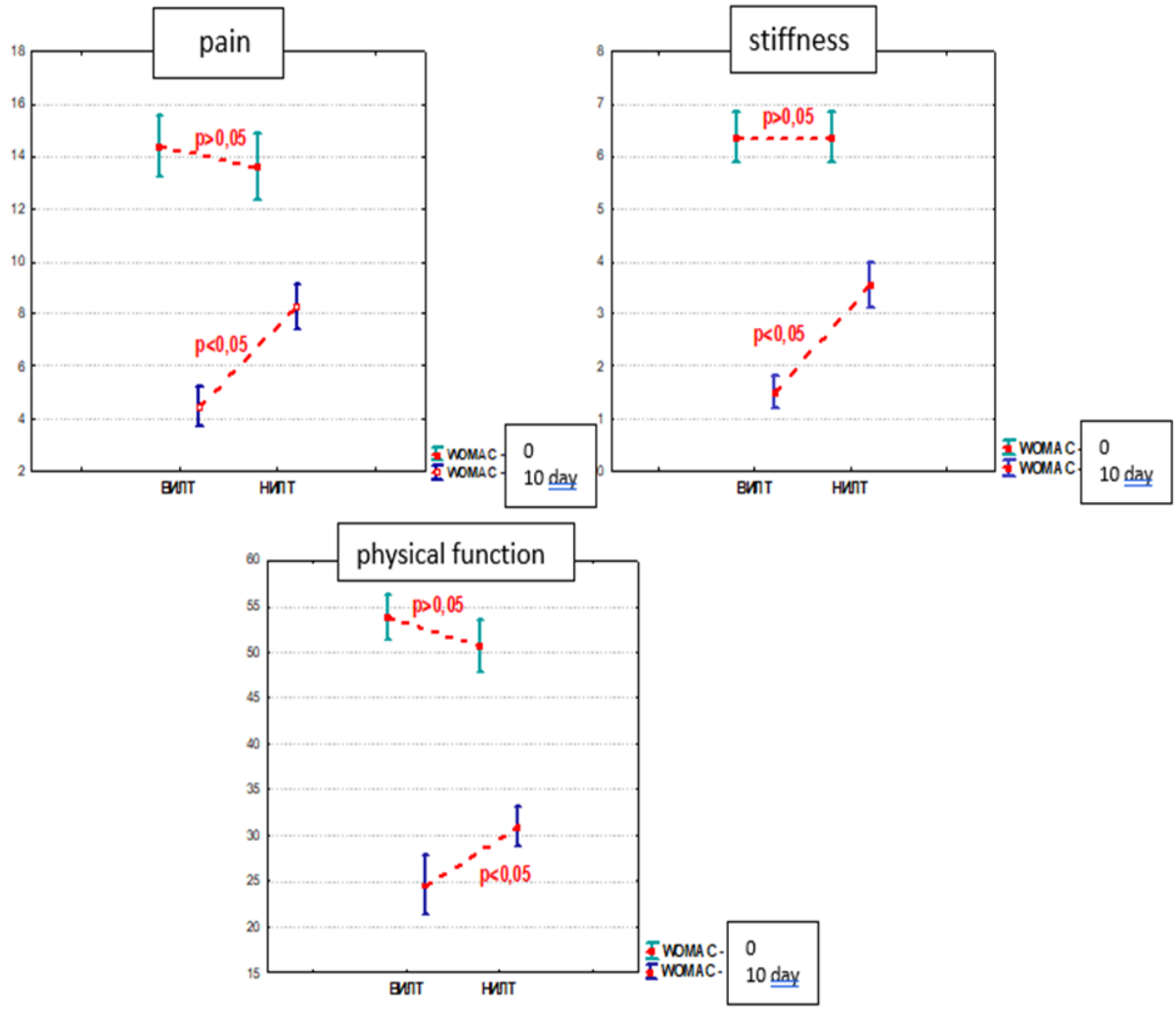


Figure 1: Comparison of WOMAC between groups and within the group individually at 0 and 10 day

The WOMAC index was assessed at baseline, after 10 therapies and after 1 month (Table 3). No significant difference was found between the two groups at baseline ($p<0.05$). A significant reduction of the WOMAC index was observed in both groups at both follow- ups compared to baseline. The maximum reduction of the WOMAC scale was noticed after 1 month (Figure 2). However, after 10 treatments a significant lower WOMAC index was observed in the HILT groups ($p<0.01$). This effect persisted and could also be observed at 1 month following therapy ($p<0.01$) (Table 3).

Table 3: Comparison of WOMAC between groups and within the group individually at three time points - 0, 10 days and 1 month

WOMAC		N	X ± SD	Min/ Max	Median (IQR)	P
0	HILT	36	74.58±10.54	55/88	78.5 (63.5-83.5)	[1]Z=1.4866; p=0.1371
	LILT	36	70.69±11.44	51/89	70 (62-79.5)	
10-Day	HILT	36	30.44±11.15	12/48	30.5 (21-40.5)	[1]Z=-4.3135; p=0.00002*
	LILT	36	42.78±8.11	25/59	44.5 (37.5-49)	
1-month	HILT	36	5.83±5.23	0/20	5.5 (1-9)	[1]Z=-7.2979; p=0.00001*
	LILT	36	40.75±9.37	22/58	40 (31-48)	
Friedman test 0/10/1 month, VILT- N=36; Chi-Square=72,011; df=2; p=0,00001* LILT -N=36; Chi-Square=53.535; df=2; p=0,00001*						
[1]**Mann-Whitney U test**			*significant p<0,05			

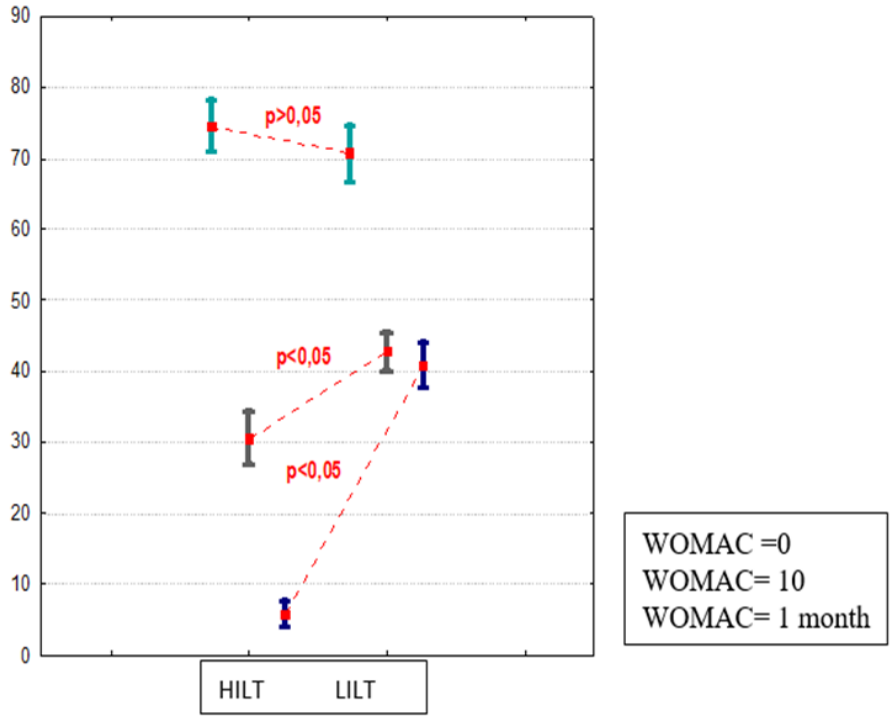


Figure 2: Comparison of WOMAC index between groups and within the group individually at three time points - 0, 10 days and 1 month

DISCUSSION

Our study revealed that both LILT and HILT treatments in patients with KOA led to reduced symptoms immediately after therapy and 1 month later. The observed result was more pronounced in patients treated with HILT laser.

Our results are similar to several other studies which used the same out-

come measure in patients with LILT treatment[15,16,17]. Several authors have confirmed the effectiveness of HILT therapy in reducing pain in different neurological and musculoskeletal disorders[18,19,20,21,22]. Specifically, studies investigated the effectiveness of HILT therapy in patients with KOA. Roheim MI *et al*. showed that HILT therapy was more effective than isolated exercising for reducing pain[23]. Siriratna *et al*. reported a more significant pain reduction measured with the WOMAC index in patients treated with HILT compared to the control group who received placebo24. The same conclusions were derived in a study published by Taher *et al*.[25].

In the last few years, studies have been published comparing the effectiveness of HILT and LILT 2[6, 27, 28]. Most of them showed positive results in the treatment of KOA. The studies were heterogeneous regarding study duration, number of controls, number of laser therapy sessions and outcome measures. For example, Vibisono *et al*. investigated the comparative effects of HILT and LLLT on leg balance in patients with KOA using the Berg Balance Scale (BBS) 26. Another study by Ahmad MA. *et al*. compared patients treated with LILT and exercise, and HILT and exercise for 12 weeks. Although both groups significantly improved regarding active knee flexion and Time Up and Go scores compared to baseline, the results were better in patients treated with HILT[27]. The double-blind randomized controlled trial by Astri SW. *et al*. also compared the outcome of treatment of patients randomized to LLLT and HILT. All patients received 6 sessions of laser therapy in combination with exercise therapy. After 6 sessions, both groups showed a significantly increased walking speed. Moreover, the improvement in pain and functional ability was faster and greater in the HILT group than in the LLLT group[28].

A more recent comparative study published by Bernadette *et al*. compared[27] subjects with KOS treated with HILT or LLLT. The recovery measured with the Knee Injury and Osteoarthritis Score (KOOS) was significantly better in the HILT patient ($p < 0.001$)[29].

In our study, the group of patients treated with HILT combined with exercises showed significantly better results in the Total WOMAC index compared to the group with LILT combined with exercises at the end of the study (evaluations were conducted at three time points: at 0-time, after 10-therapy sessions and after 1 month of treatment). This means that patients treated with HILT had a significant reduction in pain, significantly better physical function and less stiffness in the knee joints ($p=0.0001$). This is particularly important for the older population, which is also represented by a high percentage in the study (58.33%).

Our study supports the fact that HILT is a simple, non-invasive, and effective choice of treatment of patients with KOA.

Conclusion

Both LILT and HILT are effective physical modalities in reducing pain and promoting functional recovery in patients with KOA. HILT leads to significantly greater reduction in pain and stiffness, and improved physical function compared to patients with

KOA treated with LILT immediately after therapy and one month later. New high-quality studies are needed in the future involving larger patient samples and longer follow-up periods to further investigate the effects of HILT.

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