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Comparison of the effectiveness of low-energy laser treatment and sonotherapy in the healing of plantar aponeurosis enthesopathy symptoms

Agata Bloch[1], Kinga Misiak[2], Łukasz Nowicki[3], Anna Złotnik[4], Krystian Kałużny[5], AnnaKałużna[5], Magdalena Hagner-Derengowska[6], Walery Zukow[6]

1) Nicolaus Copernicus University in Toruń, Ludwik Rydygier Collegium Medicum in Bydgoszcz
2) University of Bydgoszcz in Bydgoszcz
3) FMC Medical Centre in Łódź
4) Pulmonary-Cardiological Specialistic Hospital in Torzym
5) Department of Rehabilitation, Faculty of Health Sciences, Nicolaus Copernicus University in Toruń, Ludwik Rydygier Collegium Medicum in Bydgoszcz
6) Department of Spatial Management and Tourism, Faculty of Earth Sciences, Nicolaus Copernicus University in Toruń

Abstract

The aim of this study is to compare the effectiveness of healing using low-energy laser treatment and sonotherapy in the treatment of plantar aponeurosis enthesopathy symptoms.

Material and methods: The research was carried out at the hospital in Lipno. The research group consisted of 50 people with diagnosed enthesopathy of the plantar aponeurosis and mostly with an excessive BMI index. The patients were divided into two groups. The first one consisted of 25 patients who were treated with low-energy laser therapy. The second group

with the same number of people was treated by sonotherapy. A research group of 50 people suffering from plantar aponeurosis and mostly with an excessive BMI (D = 26.9). Women: 33 and men: 17 at the age from 36 to 73 (D = 59.7).

Results: The results obtained in the VAS scale show that low-energy laser treatment and sonotherapy, as the form of ultrasounds, are effective pain treatments of the plantar aponeurosiys enthesopath. Both treatments reduce the subjective feeling of pain. Also, the intensity of pain associated with entezopathy decreases when using low-energy laser therapy. Both treatments significantly affect the reduction of edema around the plantar aponeurosis. Sonotherapy reduces pain but does not significantly affect the frequency of pain.

Both therapies proved to be effective, but the studies showed statistically significant differences between the studied groups. The improvement with a greater severity was noted in group II, treated by sonotherapy, as the form of ultrasounds.

Conclusions: The results obtained in the tests showed a therapeutic effect in reducing pain associated with plantar aponeurosis, nonetheless the comparison of both physical methods showed a statistically significant difference between the groups studied. The improvement with a greater severity was noted in group II, treated by sonotherapy, as the form of ultrasounds.

Key words: plantar aponeurosis; sonotherapy; laser treatment

Introduction

The term "calcaneal spur" is defined as plantar aponeurosis enthesopathy, i.e. inflammation in the lower - medial part of the calcaneus [1]. The calcaneal aponeurosis has been more and more frequent among patients of all ages recently. It is estimated to be in the range from 10 to 80% of the population [2].

The pain occurring in the heel area caused by the loading of the foot in everyday activities is an increasingly common reason to apply for therapy. The term "heel spur" is commonly known as plantar aphasia . Plantar fasciitis is a strong connective strand, with its onset on the heel spine, then delaminating into 5 strands and pinning the toes of the foot at the base of the phalanges. The fascia's task is to place individual muscles and shape the foot. Plantar fasciatum is increasingly subject to micro-strains, and as a result, chronic inflammation occurs in this area, resulting in chronic pain in the heel area [3, 4, 5].

In 1900, the was first calcaneal spur was described by the German scientist Plettner. Performing the radiograph of the foot, he observed a bone growth, which he connected with pain in the heel area[6]. It was the beginning of diagnostics of this affliction Radiological image clearly indicates the appearance of plantar aponeurosis in 88% of people who are suspected of this condition[7]. The occurrence of calcaneal spur is not obvious for one sex, both men and women are equally affected by the risk of this affliction. The calcaneal spur most often concerns middle-aged and elderly people, those who lead a lifestyle that requires standing or walking for a long time, as a result of excessive foot overloading. The affliction of the calcaneal spur is also closely related to the excessive BMI index[8]. It was found that prolonged standing and overweight correlate with each other. Entezopathy occurs in 90% of women and 40% of men with obesity problem[9].

Diagnosed "heel spur" requires rehabilitation. Physiotherapeutic treatments are used in it. The magnetic field, ionophoresis are basic therapies used to reduce pain and inflammation. Treatments that are also popular and beneficial are low-energy laser therapy and sonotherapy [10, 11]. Treatment of plantar apathy is limited to eliminating inflammation and reducing or relieving pain. Conservative forms include the use of unloading inserts for calcaneus, analgesic and anti-inflammatory ointments, pharmacotherapy and physical procedures. The aim of the study is to compare the effectiveness of low-energy laser therapy and sonotherapy in the treatment of plantar prone tendinopathy symptoms.

Material and methods

The research was carried out at the hospital in Lipno in a group of 50 people with diagnosed enthesopathy of the plantar aponeurosis and mostly with an exceeded BMI index. The patients were divided into 2 groups. The first 25 people were treated with low-energy laser therapy, the other group of patients was treated with sonotherapy.

Patients with diagnosed enthesopathy of the plantar aponeurosis were admitted to ambulatory procedures and a comparative assessment between the use of low-energy laser therapy and sonotherapy was done. The comparative assessment consists of two parts.

The diagnostic part was made with:

- VAS (Visual Analog Scale) scale - analogue-visual scale used for a patient’s assessment of the intensity of pain. It is assumed that the value 0 means the total lack of pain, 10- the strongest pain ever [12],

- Laitinen Questionnaire - allows you to determine the intensity and frequency of pain, the amount of analgesics used, and also to show how pain reduces physical activity [13].

The second stage was a research part. It consisted in 10 treatments. The first group underwent low-energy laser therapy made with the BTL 4000 Smart using point contact method, with the clamp with wavelength of 830 nm, laser power and the dose selected individually for each patient, taking into account the current state of the person. The other group underwent sonotherapy with the Technomex Cosmogamma Ultrasound US 13 apparatus, choosing the parameters of the treatment (1MHz, 3 minutes, fill factor: 50%, dose: 0.8W / cm^2).

Statistical analysis

Statistical analysis of the research material was performed in the Statistica v. 12.5 program. Parametric tests and non-parametric tests were used in the analysis of variables. The selected tests were conditioned by specific basic assumptions of this test. The normality of the distribution of the studied variables was measured by the Shapiro-Wilka test. Descriptive statistics have been calculated for all variables. For variables that meet the conditions of normal distribution, the mean, standard deviation and the minimum and maximum values were calculated. For variables in the interval scale, which did not meet the conditions of normal distribution, the median was shown as well as the first and third quartiles. To assess intra-group variability in two groups, Student's t-test for dependent variables or, alternatively, non-parametric Wilcoxon-pairs order test was used. In order to compare the results between the two groups, the Student's t-test for independent groups was used, or, alternatively, the U-Mann-Whitney test. The statistical significance was assumed to be $p < 0.05$.

Results

In the research group of 50 people there were 33 women and 17 men, aged 36-73 (D = 54.2). The mean BMI index of patients was 26.88 (SD = 3.18).

Table 1 presents the results of the study of a group of patients treated with non-energy laser therapy. The summary shows the results before and after a series of treatments.

Table 1: Descriptive statistics and results of t test- Student for the first group of patients before and after therapy.

Variables in group I		Descriptive statistics					Student t test	
		N	$\bar{x}$	SD	Min	Max	t	P
VAS scale	before	25	6,20	1,2247	4,00	9,00	5,921028	0,00001
	after	25	3,28	1,3077	0,00	6,00		
Laitinen questionnaire – pain increasing	before	25	1,92	0,6404	1,00	3,00	4,818944	0,00019
	after	25	1,04	0,3512	0,00	2,00		
Laitinen questionnaire – pain frequency	before	25	1,92	0,7594	1,00	4,00	2,853569	0,010163
	after	25	1,08	0,4	0,00	2,00		
Laitinen Questionnaire - the frequency of taking painkillers	before	25	1,36	0,7572	0,00	3,00	2,853567	0,010164
	after	25	0,28	0,5416	0,00	2,00		
Laitinen Questionnaire - limitation of activity	before	25	0,52	0,7141	0,00	2,00	2,857569	0,010165
	after	25	0,12	0,3317	0,00	1,00		
	after	25	1,92	0,2769	0,00	1,00		

The comparison of the p-value of the Student's t-test based on the t statistic with the significance level of $\alpha = 0.05$ allows to conclude that there is a difference in the results for the VAS scale and all Laitinen test parameters before and after treatment in the group of patients undergoing low-energy laser therapy. This difference concerns the reduction of pain symptoms measured using the VAS scale ($p = 0.00001$). Also, the severity of pain and its frequency decreased significantly ($p = 0.00019$ and $p = 0.010163$). It can be noticed that low-

energy laser therapy does not have a significant impact on improving the limitation of the physical activity of patients with painful symptoms of plantar aponeurosis, but allows for more efficient activation of patients (p = 0.01016). The frequency of taking painkillers decreased significantly (p = 0.01016). In the case of patients with chronic pain, the heel area is an important aspect of the success of the therapy.

The next table presents a summary of research results in the group where patients were subjected to sonotherapy.

Table 2: Descriptive statistics and results of t test- Student for the second group of patients before and after therapy.

Variables in group II		**Descriptive statistics**					**Student t test**	
		N	$\bar{x}$	SD	Min	Max	t	P
VAS scale	before	25	2,96	1,3064	4,00	8,00	4,659849	0,000171
	after	25	6,04	1,0985	0,00	5,00		
Laitinen questionnaire – pain increasing	before	25	1,84	0,6245	1,00	3,00	2,179449	0,042086
	after	25	0,96	0,3512	0,00	2,00		
Laitinen questionnaire – pain frequency	before	25	1,92	0,7594	1,00	4,00	2,725779	0,010816
	after	25	1,08	0,4	0,00	2,00		
Laitinen Questionnaire - the frequency of taking painkillers	before	25	1,36	0,7572	0,00	3,00	2,825788	0,010176
	after	25	0,29	0,5416	0,00	2,00		
Laitinen Questionnaire - limitation of physical activity	before	25	0,13	0,7141	0,00	2,00	2,865779	0,010188
	after	25	1,83	0,3317	0,00	1,00		

Statistical analysis of the results allows to conclude that the results of studies in the second group are statistically significant at p <0.05. It can be observed that there is a difference in the results for the VAS scale and all Laitinen test parameters before and after the treatment in the group of people undergoing sonotherapy.

Table 3 presents descriptive statistics after therapy between the examined groups I and II.

Table 3: List of results after therapy (group I and II).

Variables		**Descriptive statistics**					**Student t test**	
		N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$	N
VAS scale	Gr I	25	4,30	1,750	2,00	7,00	2,23816	0,031149
	Gr II	25	3,00	1,919	0,00	7,00		
Laitinen questionnaire – pain increasing	Gr I	25	1,25	0,444	1,00	2,00	3,327453	0,01954
	Gr II	25	0,90	0,552	0,00	2,00		
Laitinen questionnaire – pain frequency	Gr I	25	1,20	0,410	1,00	2,00	3,327453	0,001954
	Gr II	25	1,05	0,686	0,00	3,00		
Laitinen Questionnaire - the frequency of taking painkillers	Gr I	25	0,35	0,00	1,00	0,00	0,905204	0,367273
	Gr II	25	0,25	0,00	2,00	0,00		
Laitinen Questionnaire - limitation of physical activity	Gr I	25	1,20	1,00	2,00	1,00	1,838564	0,064986
	Gr II	25	0,90	0,00	2,00	1,00		

The results of both groups after therapy are slightly different. The comparison of the p-value of the student's t-test based on the t statistics with the significance level of $\alpha = 0.05$ allows to conclude that there is a difference in the results for the VAS scale ($p = 0.031149$). The results also refer to the severity and frequency of pain as measured by the Laitinen test ($p = 0.01954$ and $p = 0.001954$) after therapy in the first and second research group. On the other hand, there was no significant difference in the frequency of taking painkillers and limitation of physical activity after surgery.

Summing up, both therapies proved to be effective, but studies showed statistically significant differences between the studied groups. An improvement of greater intensity was noted in group II treated with sonotherapy.

Discussion

The calcaneal spur is a condition that affects an increasing part of the population. Since Plettner first diagnosed this problem in 1900, ongoing research is being done to find out the etiology and forms of calcaneal spur treatment.

Patients struggling with this ailment complain about the deterioration of the quality of life caused by pain. Limiting physical activity as well as taking more and more painkillers forces patients to use rehabilitation.

Many studies are based on the thesis that the formation calcaneal spurs is accompanied by overweight, predisposing to the formation of inflammation of the plantar aponeurosis [14].

The forms of treatment vary from pharmacotherapy and conservative treatment, going further through physiotherapy and kinesitherapy, ending with surgical treatment, in the form of endoscopy or arthroscopy [15].

Physical therapy is the ability to protect a patient from surgery. Straburzyńska - Lupa and Kornacka studied the use of various doses of ultrasound to reduce pain. They examined two groups of patients using the dose of 1.0 - 1.6 W / cm^2 in the first group, and in the second group - 0.6 - 0.8 W / cm^2. It turned out that there was a faster reduction of pain in the first group [16].

Boerner and collaborators studied the analgesic effects of ultrasound using doses from 0.8 to 1.2 W / cm^2. The authors of the study have observed an improvement in the patients level of pain [17].

Łukowicz and collaborators evaluated the analgesic effect of low-energy laser therapy and sonotherapy in the treatment of pain caused by calcaneal spur Patients were treated with sonotherapy at 0.8 - 1.0 W / cm^2 and low-energy laser therapy with an energy dose of 4 - 6 J / cm^2. The studies presented a similar therapeutic effect of both treatments [18].

Low energy laser therapy affects the stimulation of cellular processes. Sonotherapy has a beneficial effect on anti-inflammatory effects and thus reduces pain [19].

In summary, the analgesic and anti-inflammatory effects caused by entesopathy of the plantar aponeurosis is based on the use of physical treatments. In our research it was observed that

pain caused by calcaneal spurs was reduced when using low-energy laser therapy and sonotherapy, as the form of ultrasounds, in a similar value.

The doses used in the studied groups of patients were as follows:

in low-energy laser therapy using the point contact method with the clamp using a wavelength of 830 nm of laser power and a dose selected individually for each patient taking into account the current state of the patient. In sonotherapy a dose of frequency 1MHz was used with a fill factor of 50% (time: 3 minutes, dose: 0.8 W / cm^2, head 1 cm^2) Nevertheless, the frequency of pain is more seldom when using low-energy laser treatment. The use of sonotherapy has shown better therapeutic results and improvement of life quality of patients taking part in the research.

Rehabilitation of plantar aponeurosis enthesopathy using different therapeutic methods should be carried out regularly to ensure pain relief, resulting in improvement of patient physical condition.

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