Journal of Engineering Research and Applied Science
Available at www.journaleras.com
Volume 12 (1), June 2023, pp 2295-2300
ISSN 2147-3471 © 2023

Body-Capable Phototherapy Device

Yaşar Şen

Biomedical Engineering, Duzce University, Duzce, Turkiye

Accepted 29 May 2023

Abstract
Phototherapy is used to reduce inflammation in the skin, increase cellular activity and reduce hyperpigmentation (excessive coloration) in the skin.Phototherapy (light therapy) is a preferred method of treating various health problems using a light source.
In this study, it was aimed to create a wearable form different from the usual forms of phototherapy, especially with its use on skin diseases. Phototherapy for the treatment of skin diseases is mainly used for psoriasis, eczema, vitiligo, etc. it is used in the treatment of diseases. Phototherapy devices of different wavelengths and types have long been used in the treatment of dermatological diseases.
Broadband ultraviolet B (UVB), narrowband ultraviolet B (dbUVB), ultraviolet A1 (UVA1), Psoralen-ultraviolet A (PUVA) (Psoralen+UVA) and 308 nm excimer laser are among the preferred phototherapy options in dermatology.

Keywords: *Phototherapy, UVA, UVB, skin*

1. Introduction

Phototherapy is a method used especially in the treatment of skin diseases. The main purpose of phototherapy is to control the growth of skin cells and reduce inflammation by affecting the skin with ultraviolet (UV) rays. For this reason, phototherapy is widely used in the treatment of chronic skin diseases, especially psoriasis, eczema, vitiligo[1-4].

The wearable phototherapy device that we aim to make is a portable device that the user can carry and use at home.This device is suitable for gloves, socks, hats, etc. according to the region to be used. it can be designed in shapes and sizes.Wearable phototherapy devices are designed to increase patients' compliance with treatment and make the treatment process easier. Since these devices can be used at home, the patient can continue treatment without having to go to clinics. It is aimed to achieve similar results with phototherapy treatment applied in a clinical setting[5,6].

As can be seen from the literature review conducted in the study, skin diseases are quite common today. It was to popularize its use for skin diseases by creating a wearable form of phototherapy treatment used to prevent these diseases.

We have designed a wearable phototherapy device, but it takes more time for such projects to be heard and widespread use.

LEDs are UV light, so don't confuse this with UV. It does not contain UV rays harmful to the skin. LED therapy is a therapy suitable for regular use. Unlike chemical peeling and laser treatment, LED light therapy does not cause burns or damage. This treatment is safe for all skin types and can be conveniently used both at the center and at home

The number and placement areas of the LEDs in the study were designed taking into account the dimensions of a normal wearable adult vest.

2. Material and Method

It is LEDs that constitute the main function of the study, LED is an abbreviation consisting of the initials of the words Light Emitting Diode (light emitting diode in Turkish).

As the name suggests, LED is a diode. As we know, a diode is a two-legged semiconductor circuit element that allows current to pass in only one direction. Phototherapy methods are used in many treatments in medicine. First of all, it is used in the treatment of

Corresponding author: yasarsen@duzce.edu.tr

jaundice in infants, acne treatment and dermatological diseases such as eczema, psoriasis, vitiligo[7-9].
In this study, using the light therapy method, the device was designed in a wearable form, especially taking into account skin diseases and suitable for this.

Before starting the design, the necessary literature review was conducted, the type of beam used in phototherapy treatment, the wavelength were investigated and information about them was collected, and the appropriate material for the beam to be used was provided Jul.

SolidWorks drawing program was used for three-dimensional design. Ultraviolet B ray is preferred in the device. The design was carried out by making the used UVB ray and power adapter connections, using biocompatible textile material and bringing it into wearable form.

In order to minimize the effect of the heat released from the LEDs used in the design, insulation auxiliary materials such as fiberoptic material, quartz glass material, thermal fabric are used. The numbers and placement areas of the LEDs are designed taking into account the dimensions of a normal wearable adult vest. Thermal fabric has been used in our study to minimize the damage that the LEDs will cause to the user by heating up as a result of drawing energy.

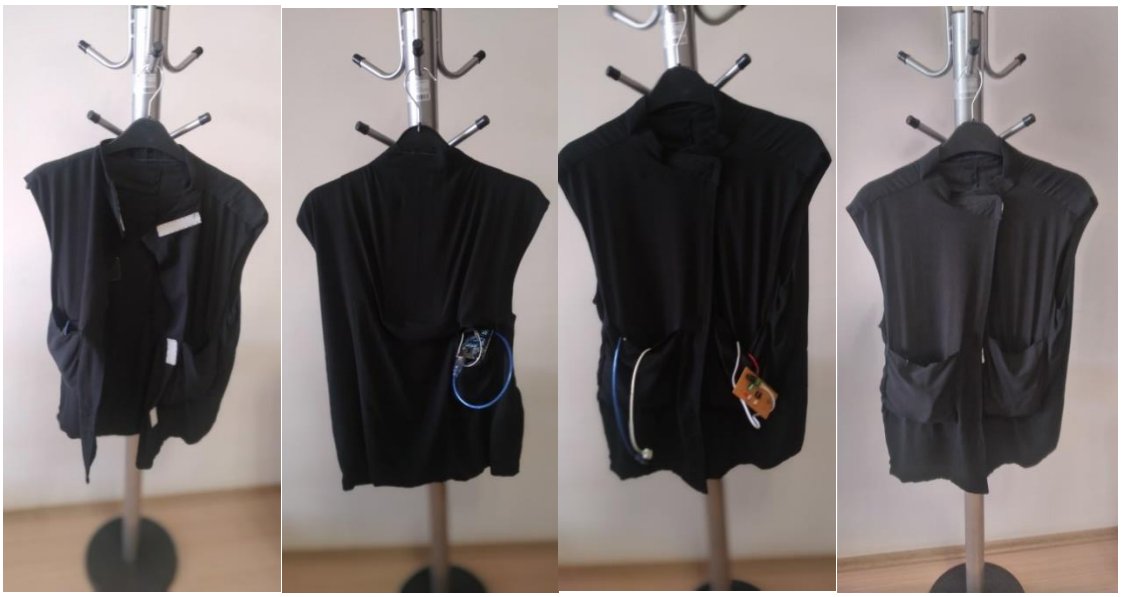

Figure 1.Designed Wearable Device for the Body (Vest)

As can be understood from the literature review, LED therapy has been used for more than 30 years. It was originally developed by astronauts to help with tissue healing and repair. It is now a popular, non-invasive skin treatment used for skin ailments such as acne, eczema, rosacea and sun wrinkles and spots.

It is used to repair the skin. The most important feature of this application is the acceleration of the skin regeneration process.LED therapy, also known as youth light, works with four different colored lights. LEDs are available in Usage Areas According to Colors;

Blue Light: Acne contains Porphyrins bacteria. Blue light has a wavelength that can kill Porphyrins bacteria thanks to its high affinity property. Blue light has a soothing effect on extremely sensitive skin.

Green Light: Calms the skin and improves its sensitivity. Suitable for combination skin types. The green light targets the cells that produce melanocytes. It prevents the production of excess melanin, prevents melanin from reaching the surface of the skin. It prevents existing spots and discoloration by breaking down melanin accumulation.

Yellow Light: It creates a detoxifying effect by regulating the blood and lymph circulation system of the skin and helps to eliminate the reddened appearance of the skin. It can be used in the suppression of early shingles.

Red Light: Stimulates collagen production. Collagen is the most important protein used in the repair of damaged tissues and the replacement of old tissues with new ones. It tightens the pores. It is

very effective in removing swelling and eliminating obvious wrinkles after surgical operation.

2.1. The Blue UV Led Data Set was used in the study

Narrow band ultraviolet B ray was used. The blue ultraviolet led used in the project is the number 2835 led, which is widely available in the market. This number indicates the size of the LED[10].

Each led in the use area with this numbering has a size of 2.8mm x 3.5mm. This led has a width of 8mm, a voltage of 12V and a light angle of 120 degrees. The storage temperature of the led is between -40°C and +80°C, and the operating temperature is between -25°C and +60°C. Dec.

Figure 2. The arrangement of the LEDs

2.2. The Data Set of the Splint Designed For The Wrist

The splint used is made of elastic and breathable perforated fabric. The inner surface of this fabric is cotton. It is a material that can be easily shaped by selecting the appropriate sizes according to the user and having adhesive tapes. In addition, the coating is made of the same material to minimize the heating of the LEDs. Thus, it is aimed to minimize the damage that the heat of the LEDs will cause to the body.

2.3. Power Adapter Data Set

The appropriate 12V power adapter has been selected for the lede used. By passing this adapter over a 1 ampere current, the current required for the led is provided and the led is lit.

3. Findings and Discussion

3.1. Findings

Studies are being carried out in the field of wearable phototherapy device technology. Among them, there is also a wearable phototherapy device designed for the treatment of knee calcification.
Research such as this has been a pioneer in our study. In the light of these researches, wearable phototherapy device has been designed for skin diseases. The classification of the findings was made according to the area in which the device will be used and the materials used.

3.1.1. Findings Related to the Classification of the Blue UV Led Dataset

Ultraviolet rays of different wavelengths are used in the treatment of skin diseases depending on the skin thickness and color of the users[11].

In this research, a narrow band blue led with an emission wavelength in the range of 280-320 nm has been preferred. In the study, which is intended to be used for knee calcification, a red LED with an emission wavelength of 630 nm was used. Figure 2 shows a schematic diagram of the led array formed by 50 LEDs on the device. Figure 3 shows a schematic diagram of the led array consisting of 55 LEDs used in the other project[12]

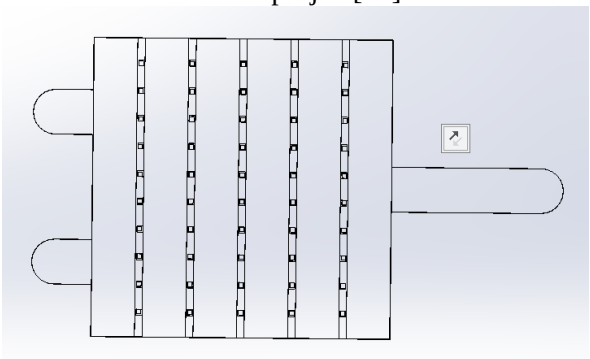

Figure 3. Schematic representation of the led array of the design. [12]

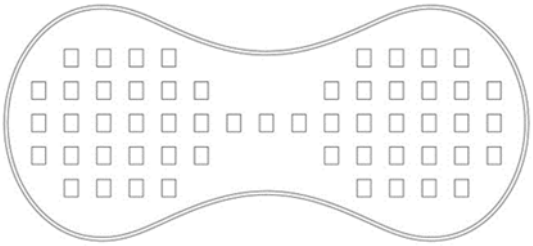

Figure 4. Schematic of the led array[12]

3.1.2. Statistical Findings regarding the Hand Wrist Splint Data Set

In our project, the placement of the led array was made on the wrist splint as shown in Figure 4. In Figure 5, in the other study, the placement of the led array was made on the led card. In both studies, the compatibility of the led bed according to the region to be used has been increased by paying attention to the production of flexible material.

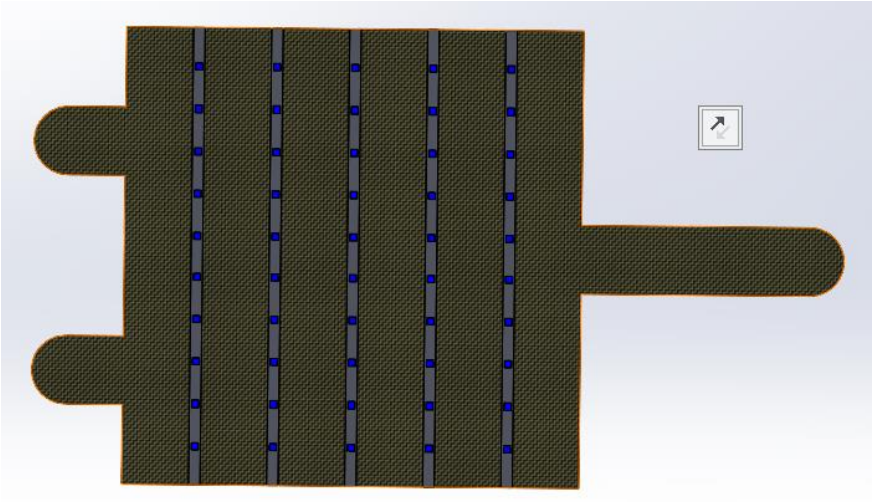

Figure 5. Placement of the led array on the splint

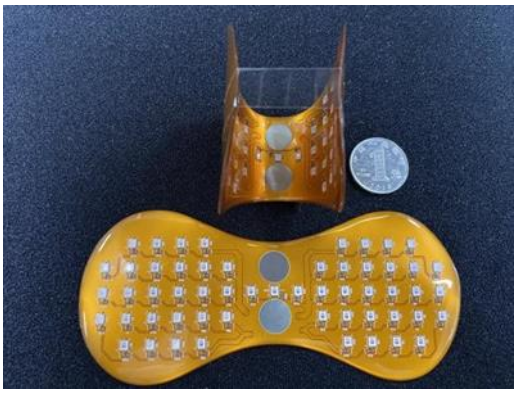

Figure 6. Flexible led board[12]

3.1.3. Statistical Findings Regarding the Power Adapter Data Set

A 12-volt power adapter was used in the project to ensure the portability of the device. In the other project, a 5-volt battery was used to meet the power requirement.

3.2. Argument

This study presents a wearable flexible phototherapy device that is attached to the desired area of the body for skin diseases. In studies in the literature on phototherapy, the structure of wearable phototherapy devices is similar in most studies[13].

Being flexible to adapt to the body and using LEDs are among such similarities. Differences between studies are shaped by the disease focused on. The wavelength and colors of the LEDs used are very important for phototherapy treatment. For example, narrow band blue LEDs with a wavelength in the range of 280-320 nm are used in the treatment of skin diseases[14,15], while a red LED with a wavelength of 630 nm is used for the treatment of knee osteoarthritis[12]. Some wearable phototherapy devices use batteries as a power source. This reduces the useful life of the device.

For this reason, in our study, the use of a power adapter was preferred instead of a battery as a power source.

4. Results and Recommendations

The aim of the research is to design a wearable form of phototherapy treatment and to spread its use in skin diseases. In the study, the design of a wearable phototherapy device for the body was carried out. But it takes time for such studies to take their place in the literature and spread their use.

Although there is a problem with the heating of the LEDs during the realization of the study, the problem has been solved to some extent by coating the led from the fabric of the hand splint in order to fix this problem. However, with the studies to be conducted on this subject, new studies can be created by developing different solution methods. Different

materials can also be used instead of fabric to solve the problem.

As can be seen from the literature review, skin diseases are quite common today. To expand its use for skin diseases by creating a wearable form of phototherapy treatment used to prevent these diseases, and at the same time the patient can maintain movement function in a certain area while completing the treatment process. In this case, it also prevents the loss of time in simple tasks that the patient can do.

Wearable phototherapy devices are designed to increase patients' compliance with treatment and make the treatment process easier. Since this device can be used at home, the patient can continue treatment without having to go to clinics.
According to the research conducted in the study, when LED applications were examined for which skin problems were used, it was found that LED therapy was used for all kinds of tissue regeneration, as well as for skin care, anti-aging treatments and deep wrinkle treatments. It has been observed that it is quite effective in the treatment of skin disorders such as warts and acne. It also helps to remove skin spots caused by sunlight and aging. At the same time, one of its effective properties is that it helps cell regeneration by promoting blood circulation. It takes several treatment sessions to see an improvement in skin appearance. The best results are usually achieved after 4-5 regular sessions.

However, with the wearable phototherapy device we have designed for the body, it is possible to perform the number of sessions at the desired time intervals in the environment you December.

In this study, using the light therapy method, the device was designed in a wearable form, especially taking into account skin diseases and suitable for this. In this way, it will be a new and promising step in the field of preventive medicine and treatment methods, which have been increasing in importance in recent years.

5. References

[1] D. S. Gençosmanoğlu, «Dermatoloji Pratiğinde Fototerapi Uygulamalarına Güncel Yaklaşım: Bölüm 2. Vitiligo, Mikozis Fungoides, Atopik Dermatit, Sklerozan Hastalıklar ve Psoriasiste Fototerapi,» Türk Dermatoloji Dergisi, pp. 51-65, 2017.
[2] H. S. Genç, «Yenidoğan Sarılığı Tedavisinde Beşikte Fototerapinin Etkinliği,» 2010.
[3] F. Farrell, E. Xie, B. Guilhabert, A.-M. Haughey, P. Connolly, M. D. Dawson ve N. Laurand, «A Wearable Phototherapy Device Utilizing Micro-LEDs,» IEEE, 2019.
[4] S. Y. Lee, C. E. You ve M. Y. Park, «Blue and red light combination LED phototherapy for acne vulgaris in patients with skin phototype IV,» Lasers in Surgery and Medicine, pp. 180-188, 2007.
[5] N. B. Meduri, T. Vandergriff, H. Rasmussen ve H. Jacobe, «Phototherapy in the management of atopic dermatitis: a systematic review,» Photodermatology, Photoimmunology & Photomedicine, pp. 106-112, 2007.
[6] F. Farrell, B. Guilhabert, A.-M. Haughey, P. Connolly, M. D. Dawson ve N. Laurand, «Wearable LED-based device for phototherapy applications,» BioMedEng, 2018.
[7] H. Hönigsmann, «History of phototherapy in dermatology,» Photochemical & Photobiological Sciences, pp. 16-21, 2013.
[8] N. M. Teske, MSc, H. T. Jacobe, MD ve MSCS, «Phototherapy for sclerosing skin conditions,» Clinics in Dermatology , cilt 34, no. 5, pp. 614-622, 2016.
[9] Y.-J. Tang, W.-W. Xu, X. Liu, R.-Z. Zang, C.-X. Xu, B. Xu, S. Cheng ve Q. Liu, «Self-control study of combination treatment of 308 nm excimer laser and calcipotriene ointment on stable psoriasis vulgaris,» International Journal of Clinical and Experimental Medicine , cilt 7, no. 9, pp. 2844-2850, 2014.
[10] T. I. Karu, «Low-Power Laser Therapy,» %1 içinde Biomedical Photonics Handbook, FL, USA, CRC Press, 2003, pp. 1-25.
[11] M. Selalmaz, A. Bülbül, Ş. Sözeri, F. Özcan, A. Kunt, G. Atar, U. Zübarioğlu, E. T. Ünal ve S. Uslu, «Yenidoğan Ünitelerinde Çalışan Hemşirelerin Sarılık Tedavisi Konusunda Uygulama Düzeylerinin Değerlendirilmesi,» Şişli Etfal Hastanesi Tıp Bülteni, cilt 49, no. 3, 2015.
[12] K. Liu, H. Chen ve Y. Wang, «Wearable Flexible Phototherapy Device for Knee Osteoarthritis,» Electronics, cilt 10, no. 1981, pp. 1-8, 2021.
[13] G. Açıkgöz ve E. Çalışkan, «Pediatrik Dermatolojide Fototerapi,» Türkderm-Deri Hastalıkları ve Frengi Arşivi Dergisi, cilt 45, no. 2, pp. 143-148, 2011.
[14] N. Aslan, «Darbeli Mod Fototerapi İle Bilirubin Konsantrasyonunun Değişiminin İncelenmesi,» 2015.
[15] S. M. Franken, C. L. Vierstra ve T. Rustemeyer, «Improving access to home phototherapy for patients with psoriasis: current challenges and future prospects,» Psoriasis: Targets and Therapy, cilt 6, pp. 55-64, 2016.

[16] T. Herzinger, M. Berneburg, K. Ghoreschi, H. Gollnick, E. Hölzle, H. Hönigsmann, P. Lehmann, T. Peters, M. Röcken, K. Scharffetter-Kochanek, T. Schwarz, J. Simon, A. Tanew ve M. Weichenthal, «S1-Guidelines on UV phototherapy and photochemotherapy,» Journal of The German Society of Dematology, cilt 14, no. 8, pp. 853-876, 2016.