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Endovenous Laser Ablation of Venous Ulcers of the Lower Limbs: A Study of the Relationship between Applied Laser Power and Age/Gender

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ABSTRACT

Endovenous laser ablation therapy (EVLA) relies heavily on the power of the laser used. Therefore, the relationships between this power and other related parameters can be studied and taken into account in order to obtain successful results from the treatment. Not only the related parameters should be tested and examined, but some other parameters that may appear unrelated to the success of the EVLA treatment should also be studied in order to improve and succeed the venous treatment. Thus, the correlation coefficient between the applied laser power and age/gender was calculated in this study. The purpose of this study was to compare the laser power used in the EVLA procedure with age for the two genders. 42 patients who suffered from venous ulcers in the lower limbs of the human body were treated with a 1470-nm diode laser. So, the correlation coefficient was($\rho_{xy} = 0.7314$) for males and ($\rho_{xy} = 0.5023$) for females.

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الاستئصال الوريدي بالليزر للقرحات الوريدية في الأطراف السفلى : دراسة العلاقة بين قدرة الليزر المستخدم والعمر لكلا الجنسين

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الكلمات المفتاحية:

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الـــخُـــلاصـــة

تعتمد طريقة الاستئصال الوريدي بالليزر *(EVLA)* بشكل كبير على قدرة الليزر المستخدم. لذلك ، يمكن دراسة العلاقات بين هذه القدرة والمعايير(المتغييرات) الأخرى ذات الصلة وأخذها في الاعتبار من أجل الحصول على نتائج ناجحة من هذا العلاج. ليس المعايير ذات الصلة فقط ، وانما يمكن أيضًا دراسة بعض المتغيرات او المعايير التي قد تبدو غير مرتبطة بنجاح طريقة الاستئصال الوريدي بالليزر. في هذه الدراسة تم حساب معامل الارتباط

بين قدرة الليزر المطبق والعمر لكلا الجنسين. كان الغرض من هذه الدراسة هو مقارنة قدرة الليزر المستخدم في طريقة *EVLA* مع العمر ولكلا الجنسين.

42 مريضا من كلا الجنسين يعانون من قرحات وريدية في الأطراف السفلى تم علاجهم باستخدام ليزر ديود 1470 نانومتر. حيث وجد ان معامل الارتباط للذكور هو $(\rho_{xy} =$ 0.7314) ومعامل الارتباط للإناث هو $(\rho_{xy} = 0.5023)$.

1. INTRODUCTION

Chronic venous insufficiency (CVI) is a common disease in the world and has several forms such as telangiectasia, varicose veins, eczema, ankle edema, pigmentation, blue veins, venous ulcers, atrophied blanche, and lipodermatosclerosis **[1, 2]**. From these forms, venous ulcers can be classified as last degree ulcerations **[3]**. The appearance and development of CVI depend on a number of personal factors. This includes aging, obesity, standing for long periods, phlebitis, gender, pregnancy, heredity, and previous injuries **[4, 5]**. Furthermore, healthy physical activities such as avoiding sitting or standing for a long time, improving calf function through exercise and physical functioning, avoiding heavy lifting and wearing restrictive clothing, limiting alcohol consumption and smoking, and avoiding obesity are cited as reasons for reducing the development of venous insufficiency [**6, 7]**. On the other hand, there are several methods used to treat chronic venous insufficiency. For examples, compression therapy, surgery, radiofrequency therapy, foam sclerotherapy treatment, and endovenous laser ablation therapy (EVLA) **[8]**. The treatment of venous ulcers and chronic venous insufficiency in the lower limbs by invasive laser is a relatively recent technique. This is because the treatment using this technique was started in approximately 2000–2001 **[9]**. As a result, there has been a great deal of research and study to try to develop the EVLA treatment. The correlation between the pain after EVLA and the deposition of laser energy was investigated **[10], and** the results of the investigations demonstrated that there is no correlation between them. A meta-analysis was used for the comparison between EVLT and high ligation (HL) in the treatment of varicose veins. For various aspects, such as intraoperative blood loss, operating time, complications, and recurrence, the comparison was conducted **[11]**. It has been proven that the overall success rate of EVLA is high and reaches to about 92%. This was proven by a systematic review and meta-analysis used in order to evaluate the efficacy of EVLA and determine the differences with this treatment when there are variations in wavelengths, applied power, and follow-up period **[12]**. A randomized clinical trial was used to compare the treatment results for varicose veins in the lower limbs using two different techniques. The comparison was for the purpose of showing the success rate and side effects of radiofrequency ablation and endovenous laser ablation during a one-year follow-up **[13]**. Similarly, treatment results by radiofrequency ablation, endovenous laser ablation, and ultrasound-guided foam sclerotherapy were used to compare the complication rate, recurrence rate, and success rate among these treatments; the difference and association of qualitative variables were tested by the Chi square test **[14]**. In our study, the correlation coefficient between the applied laser power and age/gender was calculated.

Methods

Our study included 15 males and 27 females with an age range of 28 to 60 years who had different cases of venous ulcers in the lower limbs. Briefly, after the physical examinations, an ultrasound imaging device (the Versana Essential device) was used to obtain an overview of venous defects such as **[15, 16]**:

- Diameter of the veins.
- Presence of blood reflux.
- Severity of the disease.
- Location and length of incompetent veins.
- Prevalence of incompetent valves.

Then, the treatment by EVLA will be started by applying lasers with different powers for different periods depending on the diameter of the veins and the severity of the disease. A 0.6-mm fiber probe connected to a 1470-nm diode laser (Wuhan Gigaa Optronics Technology Co., Ltd., Model: VELAS II-15D-China) was used in the treatments of all patients. The treated cases were collected from a private medical center specializing in the treatment of varicose veins and venous ulcers, the Al-Sadr Medical and Laser Therapy Unit in the Faculty of Medicine at Kufa University. Microsoft Excel software was used to extract the numerical results and graphics. The study included 15 men and 27 women of different ages. The laser used in those treatments was 1470 nm in continuous wave mode. The correlation could simply refer to the relationship between two variables. Statistically, the correlation may be defined as "a statistical measure that indicates the extent to which two or more variables fluctuate together" **[15]**. The fluctuation refers to the instability of the variables. The correlation is used in many practical applications. In this case, the correlation may be defined as "a statistical method used to assess a possible linear association between two continuous variables" **[17]**. The word association may be used in medical field, where the correlation refers to an association, connection, or any form of relationship, link or correspondence between to variables. In this case, these medical variables have no physical interpretation for their relationship. Mathematically, the correlation is calculated via the correlation coefficient (ρ_{xy}) and the two variables are x_i and y_i. The correlation coefficient is a dimensionless quantity that can be calculated using the following equation **[15]**:

$$\rho_{xy} = \frac{\sum_{i=1}^{n}(x_i-\bar{x})\,(y_i-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i-\bar{y})^2}}. \qquad (1)$$

The correlation technique has been used in EVLA and in many different cases. Endovenous therapy failure **[18]** or the success and acute thrombotic complications of lower extremity endovenous thermal ablation **[19]** are two examples. In our study, for different genders, two interesting variables were used: the patient's age (x_i) and the power of the applied laser (y_i). There is no physical interpretation of the relationship between the age of the patient and the power of the applied laser. Then ρ_{xy} is the correlation coefficient of the age and the laser power. Thus, the correlation technique helps to show the strength and type of this relationship.

Results

The practical results obtained from the treatments by EVLA were separated into two groups according to gender. Then, let x_i be the data of the age of patient and y_i be the data of the power of laser. These practical results are shown in tables (1) and (2) for males and females, respectively. In the current work and for the used variables in Equation (1), with the aid of Equation (1) and the measured results (x_i, y_i), one can calculate the correlation coefficient (ρ_{xy}) for both genders. The results of the correlation coefficient are shown in table (3).

Table (1): Gender, age, and applied laser power for male patients

Patient No. (Male) i	Age [Year] x_i	Laser Power [W] y_i
1	45	14
2	55	15
3	53	12
4	30	7
5	33	8
6	28	6.8
7	38	6.8
8	37	8

9	40	8
10	47	9.5
11	44	9
12	39	6.7
13	50	8.8
14	35	7.7
15	47	7

Table (2): Gender, age, and applied laser power for female patients

Patient No. (Female) i	Age [Year] x_i	Laser Power [W] y_i
16	30	5
17	32	6
18	34	7
19	40	9
20	47	11
21	40	9
22	35	9
23	48	10.5
24	50	7.5
25	30	7.5
26	33	6.8
27	34	7
28	53	7.5
29	40	9
30	40	9.3
31	50	8
32	37	10
33	59	11
34	29	7
35	50	8
36	48	10
37	40	10
37	37	10
39	60	10
40	25	9
41	43	11
42	49	10

Table (3): The correlation coefficient of each gender

Gender of patients	Correlation coefficient
Males	0.7314
Females	0.5023

These practical results are shown graphically in figures (1) and (2). Figure (1) shows the distributions of the measured values of both the power of the applied laser during the treatment and the age for the males, while figure (2) shows the same concept but for the females.

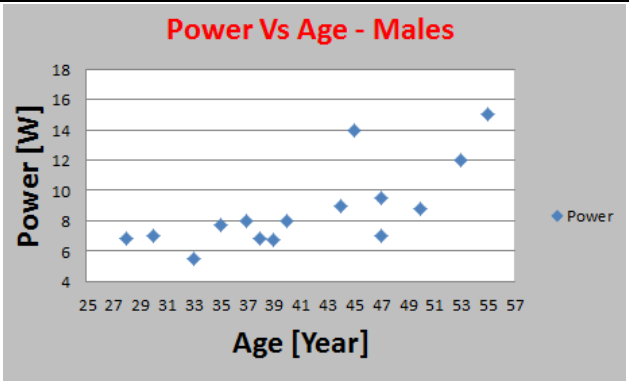

Figure (1): Distributions of the applied laser values with respect to age for the male patients.

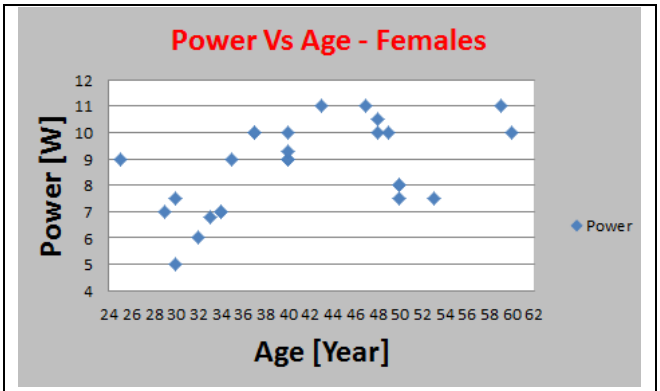

Figure (2): Distributions of the applied laser values with respect to age for the female patients.

Discussion

The appropriate applied laser power for this procedure is one of the most important reasons for the success of EVLA **[20]**. In this treatment, the choice of the applied laser power is based on the severity of the case, specifically on the diameter of the treated vein. Therefore, this laser power must be appropriately determined in order to protect the surrounding tissues and the closure of the treated vein. As mentioned above, the correlation coefficients are used to assess the strength and direction of the linear relationships between the age of the patient and the power of the laser. It is obvious from tables (1 and 2) that the power of a laser changes with age, but how and why? Or is there any kind of relationship between them? Thus, the calculation of the correlation coefficient may show the type of relationship. As in Table (3), the calculation shows that the correlation coefficient for males is ($\rho_{xy} = 0.7314$). This value may be described as a strong positive linear relationship. This value means the following:

- There is a high positive correlation between the power of the laser and age for males because ($\rho_{xy} > 0.5$).
- The age is an important factor in determination of the power of laser for males but it is not the only influencer.
- It incidences that the venous diseases are more effective in the elderly males and that clear in figure (1) or the age is an important factor.

For females, table (3) shows that the correlation coefficient is ($\rho_{xy} = 0.5023$). This value means the following:

- A moderate positive correlation ($\rho_{xy} \approx 0.5$).
- The positive value indicates that there is an associated relationship between the age of the patient and the power of the laser. But this case is lower than the case of males.

That means that the age of females is a less important factor in the determination of the power of laser. Such a case may be attributed to the fact that venous diseases affect women at different ages and that the women are more susceptible to these diseases at different ages, as mentioned in the study **[21]**. That is quite clear in figure (2). On the other hand, the correlation coefficient between applied laser power and age for females was different than in males. This difference may be attributed to the physiology of the body of each gender (like pregnancy, etc.). Thus, according to the results, the applied laser power does not have a direct relationship with age according to the correlation coefficient, because females' infection depends on other causes other than age. In addition, the duties of each gender may be related to the social culture of each society. For that reason, it is expected that the correlation coefficient of females may has obvious different values in each society, which would indicates the role of females (duties) in that society.

Conclusion

Our study demonstrated that the correlation coefficient between the power of the applied laser and age is greater in males than females. This means that women are more likely to develop chronic venous diseases at different ages, whereas older men are more likely to develop these diseases.

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