Original paper

Comparing the therapeutic effect of pulsed dye laser and pulsed dye laser plus CO_2 in port wine stain

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Abstract

Introduction: One of the most common congenital vascular abnormalities in the dermal area of the skin is the port-wine stain (PWS).
Aim: Researchers are trying to introduce more effective new methods of treatment of PWS.
Material and methods: This clinical trial study was conducted on 60 patients in Huanggang Central Hospital during May 2020 to June 2021. Pulsed dye laser (PDL) only and PDL plus CO2 methods were used to treat PWS, the clearance scores of patients were assessed for both methods, and the side effects were examined.
Results: The mean age of the patients was 26.87 ±9.67 years. The majority of the patients (80%) were female. Thirty-four (56.66%) patients had PWS in the malar area, 14 (23.33%) on their forehead, 5 (8.33%) on their chin, and 7 (11.7%) on neck. The efficacy of the treatment through clearance score shows that the quantitative mean of the clearance score of the patients in the PDL method was 2.71 ±0.54, and in the CO2 + PDL method it was 2.72 ±0.56 ($p > 0.05$). The qualitative comparison of clearance scores indicated that in the PDL method, 18 (30%) patients had acceptable clearance, 30 (50%) patients had good clearance, and 12 (20%) patients had excellent clearance. Also, for the PDL plus CO_2 method, 25 (41.766) patients had acceptable clearance, 23 (38.34%) patients had good clearance, and 12 (20%) patients had excellent clearance.
Conclusions: For PWS patients under treatment with PDL plus CO_2, the hyperpigmentation side effect was greater than in patients with underlying PDL only.

Key words: port wine stain, pulsed dye laser, CO_2 laser.

Introduction

One of the most common congenital vascular abnormalities in the dermal area of the skin is the port wine stain (PWS), with a prevalence of 0.3–0.9% in newborns. This abnormality occurs on the face in 66% of cases, so this disease is an important clinical problem that impacts the involved patients [1]. This lesion can appear in different areas of the patient's skin [2]. This benign skin lesion causes a dark red to pinkish colour [3]. These lesions progressively become thicker and darker with age and also remain isolated; they are sometimes related to complex syndrome anomalies [4]. Some PWS patients have cerebrovascular anomalies, called Sturge-Weber Syndrome, which can cause a seizure in the involved person [5]. This vascular anomaly is observed in about one-tenth percentage of the population at birth without a gender preference. It is generally sporadic; however, some cases of familial inheritance have been reported [6, 7]. The pathogenesis of PWS remains unknown, but several mechanisms including vascular ectasia, weakness in neurological control, vascular pressure, overexpression of vascular endothelial growth factor or its receptors, and vascular hyperplasia can be involved in its generation [8].

Port wine stain treatments including surgery, skin grafting, isotope therapy, cryosurgery, and tattooing to cover the lesions [8]. These methods can lead to the development of side effects such as scars and permanent depigmentation or it is difficult to treat PWS without scarring [9–11]. So, laser therapy with pulsed dye laser (PDL) with epidermal cooling is a common treatment due

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to the low incidence of side effects. However, in the majority of PWS cases, in malice of multiple PDL sessions, complete clearance of lesions is not attained, and some parts of the lesions will remain resistant to treatment [12]. Previous studies have shown that PDL at 585 and 595 nm wavelengths is the gold standard of PWS treatment, with a high absorption coefficient in haemoglobin and oxyhaemoglobin. In addition, pulsed Nd : YAG laser and IPLS have also been used for the treatment of PWS lesions, which, according to studies conducted in this regard, have had different results in improvement and recurrence of these lesions [12–14].

Aim

Because various studies have been unable to find a definitive method for the treatment of these patients and also because the effectiveness of adding other lasers along with PDL has not been reported, the aim of this study was to compare the efficacy of PDL only and PDL + CO_2 lasers in the treatment of PWS.

Material and methods

This clinical trial study was conducted on 60 patients in Huanggang Central Hospital from May 2020 to June 2021. PDL only and PDL plus CO_2 methods were used to treat PWS, and the clearance scores of patients were assessed for both methods and the side effects were examined.

Inclusion and exclusion criteria

Inclusion criteria consist of all selected patients who came to our department, and exclusion criteria were lactating or pregnant women, patients with hypertrophic and colloid scarring, and active infection or acne in the treatment areas.

The efficacy of PDL only treatment and PDL plus CO_2 treatment were compared and investigated. Patients with PWS, who were older than 10 years of age, were evaluated. At first, each person's lesions were divided into 2 parts, and after local anaesthesia with EMLA cream, one part was initially treated by CO_2 laser with a power of 8 W/cm square and for a duration of 400 µs with cooling. After clearing the skin with saline-impregnated gauze, the second phase was performed with a power of 7 W and with the same duration. Then, the entire surface of the lesion was treated with PDL with a power of 9 J/cm^2 and a wavelength of 585 nm and a speed of 350 µs. After the laser, local antibiotics and sunscreen were prescribed for all patients, and they were recommended to dress the treated area twice a day. At the subsequent sessions performed at intervals of 1 month, the total lesion of each individual was treated with PDL only. The lesions of patients were photographed before and after the treatment, and the photos were evaluated by a dermatologist who was not involved in the treatment of the patients. Patient evaluation was performed using the clearance score. According to this scoring method, a score of 1 (weak) was assigned to clearance less than 25%, a score of 2 (acceptable) was assigned to 26–50% clearance, a score of 3 (good) to 51–75% clearance, and a score of 4 (excellent) was assigned to 76 to 100% clearance. After 6 treatment cycles, CS was calculated, and the results were compared between the 2 groups. It should be noted that the common side effects in the patients of the present study included purpura and hyperpigmentation; purpura resolved in all patients after 1 to 2 weeks, and hyperpigmentation was also controlled by topical combined drugs containing hydroquinone, tretinoin, and poorly controlled corticosteroids.

Statistical analysis

The mean and standard deviation were used in quantitative variables, and frequency and percentage in qualitative variables, in order to describe the data. Paired *t*-test and, if necessary, the generalized estimating equation method were used for data analysis by SPSS software.

Results

The mean age of the patients was 26.87 ±9.67 years. Moreover, most (80%) patients were female. Thirty-four (56.66%) patients had PWS in the malar area, 14 (23.33%) on their forehead, 5 (8.33%) on their chin, and 7 in (11.7%) on the neck.

Efficacy

The efficacy of the treatment through the clearance score shows that the quantitative mean of the clearance score of the patients in the PDL method was 2.71 ±0.54 and in the CO_2 + PDL method it was 2.72 ±0.56, and no statistically significant difference was observed in the mean clearance score of the 2 methods ($p > 0.05$).

Qualitative comparison of clearance scores

The qualitative comparison of clearance scores indicated that in the PDL method, 18 (30%) patients had acceptable clearance, 30 (50%) patients had good clearance, and 12 (20%) patients had excellent clearance. Also, in the PDL plus CO_2 method, 25 (41.766) patients had acceptable clearance, 23 (38.34%) patients had good clearance, and 12 (20%) patients had excellent clearance. Also, no significant statistical difference was found between the clearance scores of patients in these 2 methods ($p = 0.21$). Investigation of the efficacy of treatment by clearance score in the PDL method according to age ($p = 0.68$) and gender ($p = 0.32$) indicated no statistical difference in the quantitative means of clearance scores. Investigation of the efficacy of treatment by clearance score in the PDL + CO_2 method according to age ($p = 0.44$) and

gender (p = 0.26) indicated no statistical difference in the quantitative means of clearance scores of the 2 age ranges (Tables 1 and 2).

Side effects

Finally, investigation of PDL side effects showed that all patients had purpura, and one also had hyperpigmentation. In addition, examining the complications of the PDL+ CO_2 method showed that all patients had purpura and 4 had hyperpigmentation.

Discussion

PWS is one of the most important referrals of the dermatology department, which requires special attention to increase the quality of life of patients. Although various pharmacological and non-pharmacological treatments have been introduced for this disease, the effectiveness of these treatments is still under criticism. Different lasers have been used to treat these patients, but no comprehensive research has been published to compare these treatments. Therefore, in this study, lasers were compared. As shown in the results section, in general, not only did the efficacy of the 2 methods of PDL only and CO_2 + PDL show no significant statistical difference, but also the complications were the same in both of them, and only hyperpigmentation in the CO_2 + PDL method was greater than the that of PDL-only method. In order to know more about the conditions of the society of the present study, after the conducted research and the patients' clinical similarities and differences with other patients, the obtained results should be compared with other performed studies; here, several studies are investigated. For example, in 2014, Zhang *et al.* compared the effects of PDL and photodynamic therapy PDT in the treatment of PWS of the face in children. They used the wavelength of 585 nm without cooling in treatment with PDL. In the PDT method, patients received a slow-acting injection of hemoporfin at a dose of 3.5 mg/kg bodyweight, and patients were followed up for 2 months

Table 1. Comparison of clearance score between the 2 groups and by age and gender

Groups	Variable		Index		*P*-value
			Mean	SD	
PDL	Age	< 30	2/70	0/54	0.44
		> 30	2/71	0/77	
	Gender	Male	2/74	0/60	0.72
		Female	2/79	0/62	
CO2 + PDL	Age	< 30	2/61	0/84	0.64
		> 30	30	1/00	
	Gender	Male	2/49	0/68	0.53
		Female	2/88	0/72	
Comparison	PDL		2/71	0/54	1.00
	CO_2 + PDL		2/72	0/56	

Table 2. Comparison of clearance score by 3 qualities percentage score between the 2 groups and by age and gender

Group	Variable		26–50% acceptable clearance		51–75% good clearance		76–100% excellent clearance		*P*-value
			N	%	N	%	N	%	
PDL	Age	< 30	8	25.0	17	53.12	7	21.81	0.68
		> 30	10	35.71	13	46.42	5	17.86	
	Gender	Male	3	25.0	7	58.33	2	16.67	0.32
		Female	15	31.25	22	45.83	11	22.91	
CO2 + PDL	Age	< 30	14	43.75	11	34.37	7	21.88	0.44
		> 30	11	39.28	12	42.85	5	17.85	
	Gender	Male	4	33.33	6	50.0	2	16.67	0.26
		Female	18	37.5	11	22.91	19	39.58	
Comparison	PDL		18	30.0%	30	50.00	12	20.0	
	CO_2 + PDL		25	41.66%	23	38.34	12	20.0	0.21

after treatment. In the group treated with PDL, 14 (10.9%) had excellent result, 58 (45.3%) had good result, 42 (32.8%) had acceptable results, and 11 (7.6%) cases had poor results in the treatment of lesions. In the group treated with PDT (132 persons), 33 (25%) cases had excellent results, 60 (45.5%) had good results, 26 (19.7%) had acceptable results, 10 (7. 6%) had poor results, and 3 (2.3%) did not get any results. In the analysis of these statistics, although the number of excellent results in the PDT group was higher than in the PDL group, in total, there was no significant statistical difference between treatment with PDL and PDT [15]. Also, in the present study, PDL only and PDL with the other laser (CO_2) did not show a significant difference in the efficacy of treatment, but the difference between this study and the aforementioned study is the excellent clearance rate, which in the present study, with a value of 13.3%, is more than their study, with the value of 10.9%. Moreover, in the present study, the complications of treatment were studied further than in the study of Zhang. In another study in India, Thajudheen *et al.* examined the treatment of PWS skin lesions by using a flash lamp pumped pulsed dye laser in Indian patients. Patients underwent laser therapy for at least 6 to 8 months in monthly intervals, depending on the extent and depth of the lesions. According to the results obtained in this study, none of the patients experienced complete recovery and complete elimination of the lesions, and the highest response to treatment was observed in 13 patients with an improvement of more than 80%. They cited that age has a significant effect on the result of the treatment, and children younger than 5 years have a better and faster response to presented treatment; hence, 60% of children responded to treatment with a score of more than 2, which represents 41–60% improvement, after 6 to 8 sessions of treatment. Adults required more than 9 sessions to show the same recovery. In addition, there were no major and significant complications among patients after treatment and during follow-up [16]. However, contrary to their study, no results were observed in the present study on the relationship between age and treatment that this finding may be related to the difference in the number of samples of the two studies as well as the different age differences in patients in addition to the difference in the statistical society of the two studies; because in the current study, only one person aged 10 years and another teenager aged 18 years old were investigated, and other patients were in higher age intervals closed to each other, and this lower sample and less age dispersion have been the reason led to a lower chance to examine the effects of age on therapeutic efficacy more specifically. In a study performed in Spain in 2001, Del Pozo and Fonseca examined the Port Wine Stain nodules in adults, and they presented a report on the treatment of 20 patients using CO_2 laser. For laser treatment of patients' lesions, they applied a CO_2 laser of 10 W/m^2 and a period of 90 µs on all areas of the lesions. After the first laser treatment course, they manually removed the skin of the area with lesion using saline-impervious gauze. The second session of laser therapy was performed according to the parameters of the first session. In the end, based on their obtained results, all the Port Wine Stain lesions recovered by more than 75%, resulting in a score of 4. In all patients, nodules and hypertrophies disappeared and a clear surface of the lesions was obtained. No therapeutic side effect was observed in the applied treatment method. Hyperpigmentation after inflammation was observed in 1 patient; mild and localized hypertrophic scars were seen in 2 patients who were treated using silicone bandages on the affected areas within 3 months [17]. Part of the present study was similar to their applied method, and in addition to the common use of CO_2 in both studies, the index of the investigation of treatment efficacy was similar in both; nevertheless, the main difference between the 2 studies was the side effects of the CO_2 laser, because in the current study hyperpigmentation was greater than that in their study, while in their study scars were also observed, but in the present study this complication was not observed.

Conclusions

There was no significant difference between the treatment of PWS with the PDL-only method and the CO_2 + PDL method. Nevertheless, investigation of the treatment side effects shows that in patients receiving PDL + CO_2, hyperpigmentation complications were greater than those of PDL only.

Conflict of interest

The authors declare no conflict of interest.

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